The University of Iowa
Iowa City, Iowa 52242

University Hygienic Laboratory

(319) 353-5990

RECEIVED NOV 2 2 1982

11/18/82
N.

18 November 1982

E.A. Hickok and Associates
545 Indian Mound
Wayzata, MN 55391

Attn: Mr. George Boyer

Dear George;

The attached results are the ones reported to you on 12 November 1982 by telephone.

Sincerely,

Armand F. Lange, Ph.D.

Armand F. Lange, Ph.D.
Chief, Organic Analytical Division

lm

cc: Dr. Splinter
Dr. Hahne
Ms. Cain
Mr. Brewer
File

Iowa City, Iowa 52242

RECEIVED OCT 1 8 1982

University Hygienic Laboratory

(319) 353-5990

1847

13 October 1982

E. A. Hickok and Associates
545 Indian Mound
Wayzata, MN 55391

ATTN: Mr. George Boyer

Dear George:

Attached are the results of the PNA analyses of the samples received from Frank Matthews on 15 September 1982.

Sincerely,

Armand F. Lange, Ph.D.

Armand F. Lange, Ph.D.
Chief, Organic Analytical Division

cmw

cc: Dr. Splinter
Dr. Hahne
Ms. Cain
Mr. Brewer
File

DEPTH TO INLET 801'

9626-18

EUGENE A HICKOK IDENTIFICATION Q m/e Compound	5122 OW23 11/4/82 Time 0 FIG UHL# 2-4158 µg/L	5123 OW23 11/5/82 Time 22 IG UHL# 2-4159 µg/L	Reagent Blank µg/sample
117 2,3-Dihydroindene	15	33	<1
115 Indene	8	75	<1
128 Naphthalene	<1*	480	<1
134 Benzo[b]thiophene	2	32	<1
129 Quinoline	<5	<5	<1
142 2-Methylnaphthalene	3	100	<1
117 Indole	<1	<1	<1
142 1-Methylnaphthalene	66	80	<1
154 1,1'Biphenyl	29	30	<1
152 Acenaphthylene	18	33	<1
154 Acenaphthene	54	68	<1
166 Fluorene	100	65	<1
178 Phenanthrene	180	100	<1
178 Anthracene	65	14	<1
179 Acridine	4	5	<1
179 Phenanthridine	1	<1*	<1
167 Carbazole	9	27	<1
202 Fluoranthene	150	23	<1
202 Pyrene	120	19	<1
228 Benz[a]anthracene	14	2	<1
228 Chrysene	15	1	<1
252 Benzo[b]fluoranthene	9	<1*	<1
252 Benzo[k]fluoranthene	10	<1*	<1
252 Benzo[e]pyrene	10	<1*	<1
252 Benzo[a]pyrene	18	<1*	<1
252 Perylene	2	<1*	<1
276 Indeno[1,2,3 CD]pyrene	4	<1*	<1
278 Dibenz[a,h]anthracene	4	<1*	<1
276 Benzo[g,h,i]perylene	5	<1*	<1

*Compound present, but below quantitation limit

545 Indian Mound
Wayzata, Minnesota 55391
(612) 473-4224

October 21, 1982

Mr. Mike Hansel
Regulatory Compliance Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

Re: St. Louis Park Well Abandonment Program

Dear Mr. Hansel:

Enclosed herewith are the results of the samples taken during the September 13, 1982 pumping test. The pump inlet was at a depth of 801 feet.

The pumping test was abandoned after four (4) hours because the packer was leaking. The pump was removed and reset and a pumping test run on September 17, 1982. The samples taken during this pumping test will be forwarded to you shortly.

Sincerely,

EUGENE A. HICKOK AND ASSOCIATES

George Boyer

George W. Boyer, P.E.
Vice President

bt

Enclosure

DEPTH, INLET 801' MIZ

F. A. Hickok & Associates Identification	OW 23; Formation MS; 9-13-82						9/17/82
	Time 0:00	Time 0:30	Time 1:00	Time 2:00	Time 4:00 (Duplicate GC/MS run)		5:15 MS
UHL #	2-3289	2-3290	2-3291	2-3292	2-3293	2-3293	2-3893
Q m/e Compound							
117 2,3-dihydroindene	15	12	5.0	3.2	3.9	4.1	34
115 Indene	42	37	6.9	3.5	4.1	5.0	190
128 Naphthalene	400	420	<1**	<1**	<1**	<1**	3000
134 Benzo[b]thiophene	15	12	4.3	3.1	2.6	2.7	58
129 Quinoline	<1	<1	<1	<1	<1	<1	<10*
142 2-methylnaphthalene	560	440	<1**	1.8	<1**	<1**	2300
117 Indole	<1	<1	<1	<1	<1	<1	<10*
142 1-methylnaphthalene	310	260	25	14	9.2	9.4	1500
154 1,1'biphenyl	120	86	7.6	4.7	3.4	3.7	350
152 Acenaphthylene	390	230	18	8.4	5.7	6.1	780
154 Acenaphthene	320	170	22	13	8.6	9.5	850
166 Fluorene	530	490	28	17	9.0	10.1	1900
178 Phenanthrene	2,500	2,100	38	21	7.6	8.2	3500
178 Anthracene	590	460	17	10	2.8	3.2	1400
Acridine	29	18	3.3	1.8	<1**	1.0	110
179 Phenanthridine	34	25	1.6	<1**	<1**	<1**	40
167 Carbazole	28	18	<1**	<1**	<1**	<1**	160
202 Fluoranthene	1,700	1,400	46	21	7.6	8.1	2300
202 Pyrene	1,500	1,200	38	18	6.5	6.8	1900
228 Benz[a]anthracene	680	460	15	8.0	2.3	2.4	1500
228 Chrysene	580	420	12	6.4	3.0	3.0	1200
252 Benzo[b]fluoranthene	530	330	9.7	5.6	2.6	2.8	1000
252 Benzo[k]fluoranthene	330	300	7.1	4.1	2.4	2.4	800
252 Benzo[e]pyrene	310	280	6.4	3.4	1.7	1.8	660
252 Benzo[a]pyrene	570	450	11	6.2	2.5	2.5	980
252 Perylene	85	80	2.2	1.8	<1**	<1**	250
276 Indeno[1,2,3 CD]anthracene	290	200	6.4	2.9	1.7	1.6	300
278 Dibenz[a,h]anthracene	81	43	2.0	1.6	<1**	<1**	240
276 Benzo[g,h,i]perylene	310	190	5.9	3.1	1.5	1.5	300

All values in µg/L (PPB)

*Excessive amounts of other compounds present required higher detection limit.
Detection Limit 1 µg/L
Compound detected but below quantitation limits
(Samples at Time 0:00 and 0:30 contained large amounts of sediment.)

9626721

DATE		8/5	8/[illegible]	8/[illegible]	8/6	[illegible]	[illegible]	8/[illegible]	8/7
HOUR						0	8	16	24
FORMATION		OAK LAKE		[illegible]	E.C	E.C	E.C	E.C	E.C.
PACKER									
DEPTH, INLET			100'	665.[illegible]	[illegible]	[illegible]	8045	804.5	804.5
Q m/e	Compound	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L	μg/L
117	2,3-dihydroindene	<1	16	14	15	102	12	5	12
115	Indene	<1	17	21	16	204	32	14	31
128	Naphthalene	<1	11	72	6	1287	71	52	78
134	Benzo[b]thiophene	<1	10	13	7	154	9	5	10
129	Quinoline	<5	<5	<5	<5	<5	<5	<5	<5
142	2-methylnaphthalene	<1	18	40	17	2241	47	12	25
117	Indole	<1	2	<1*	2	156	<1*	<1*	1
142	1-methylnaphthalene	<1	233	42	53	1497	49	16	27
154	1,1'biphenyl	<1	23	19	16	788	9	3	8
152	Acenaphthylene	<1	34	22	22	808	12	8	12
154	Acenaphthene	<1	326	31	41	1628	26	9	24
166	Fluorene	<1	263	36	62	1757	26	17	20
178	Phenanthrene	<1	659	85	114	5249	29	16	22
178	Anthracene	<1	169	16	37	2004	7	3	4
179	Acridine	<1	22	5	5	295	<1*	<1*	5
179	Phenanthridine	<1	11	<1*	1	399	<1*	<1*	<1*
167	Carbazole	<1	3	12	3	3013	7	4	7
202	Fluoranthene	<1	428	40	68	4334	14	7	8
202	Pyrene	<1	291	26	52	3662	12	5	7
228	Benz[a]anthracene	<1	152	16	21	1748	6	<1*	1
228	Chrysene	<1	122	12	19	1628	4	<1*	<1*
252	Benzo[b]fluoranthene	<1	122	11	15	1301	2	<1*	<1*
252	Benzo[k]fluoranthene	<1	121	7	11	1028	1	<1*	<1*
252	Benzo[e]pyrene	<1	111	7	11	928	1	<1*	<1*
252	Benzo[a]pyrene	<1	122	12	16	1498	2	<1*	1
252	Perylene	<1	37	3	5	506	<1*	<1*	<1*
276	Indeno[1,2,3 CD]pyrene	<1	72	3	15	1612	1	<1*	<1*
278	Dibenz[a,h]anthracene	<1	26	1	5	588	<1*	<1*	<1*
276	Benzo[g,h,i]perylene	<1	68	3	17	944	1	<1*	<1*

9626722

EUGENE A HICKOK IDENTIFICATION Q m/e	Compound	OW23 4977-78 form. fig Time 0 10/18/82 RRR# 2-3972 691	OW23 4979-80 formation fig Time 24 10/19/82 RRR# 2-3971 691	11/4/82 0 IG Good 688.5	11/5/82 22 IG GOOD 688.5
117	2,3-Dihydroindene	9	8	15	32
115	Indene	25	20	8	75
128	Naphthalene	150	100	41	480
134	Benzo[b]thiophene	8	7	2	32
129	Quinoline	<5	<5	<5	<5
142	2-Methylnaphthalene	43	15	3	100
117	Indole	<1	<1	<1	<1
142	1-Methylnaphthalene	43	23	66	80
154	1,1'Biphenyl	13	5	29	30
152	Acenaphthylene	14	6	18	33
154	Acenaphthene	36	13	54	68
166	Fluorene	45	13	100	65
178	Phenanthrene	87	23	180	100
178	Anthracene	16	4	65	14
179	Acridine	5	1	4	5
[illegible]	Phenanthridine	<1*	<1*	1	<1
167	Carbazole	9	5	9	27
202	Fluoranthene	51	9	150	23
202	Pyrene	44	7	120	19
228	Benz[a]anthracene	12	2	14	2
228	Chrysene	9	2	15	1
252	Benzo[b]fluoranthene	8	2	9	<1
252	Benzo[k]fluoranthene	7	1	10	<1
252	Benzo[e]pyrene	7	1	10	<1
252	Benzo[a]pyrene	13	2	18	<1
252	Perylene	2	<1*	2	<1
276	Indeno[1,2,3 CD]pyrene	5	<1*	4	<1
278	Dibenz[a,h]anthracene	2	<1*	4	<1
276	Benzo[g,h,i]perylene	4	1	5	<1

*Compound present below quantitation limit

9626723

UNIVERSITY HYGIENIC LABORATORY

EUGENE A HICKOK ID: Water OW23 Formation MS Time - 4:30 9-17-82

Q m/e	Compound	2-3893 µg/L	Reagent Blank µg/sample
117	2,3-dihydroindene	34	<1
115	Indene	190	<1
128	Naphthalene	3000	<1
134	Benzo[b]thiophene	58	<1
129	Quinoline	<10*	<1
142	2-methylnaphthalene	2300	<1
117	Indole	<10*	<1
142	1-methylnaphthalene	1500	<1
154	1,1'biphenyl	350	<1
152	Acenaphthylene	780	<1
154	Acenaphthene	850	<1
166	Fluorene	1900	<1
178	Phenanthrene	3500	<1
178	Anthracene	1400	<1
179	Acridine	110	<1
179	Phenanthridine	40	<1
167	Carbazole	160	<1
202	Fluoranthene	2300	<1
202	Pyrene	1900	<1
228	Benz[a]anthracene	1500	<1
228	Chrysene	1200	<1
252	Benzo[b]fluoranthene	1000	<1
252	Benzo[k]fluoranthene	800	<1
252	Benzo[e]pyrene	660	<1
252	Benzo[a]pyrene	980	<1
252	Perylene	250	<1
276	Indeno[1,2,3-CD]anthracene	300	<1
278	Dibenz[a,h]anthracene	240	<1
276	Benzo[g,h,i]perylene	300	<1

*Excessive amounts of other compounds present required higher detection limit.

9626724

A. Hickok & Associates Identification	OW 23; Time 0:00	Formation MS; Time 0:30	Time 1:00	9-13-82 Time 2:00	Time 4:00 (Duplicate GC/MS run)		Reagent Blank
UHL #	2-3289	2-3290	2-3291	2-3292	2-3293	2-3293	
Q m/e Compound							
117 2,3-dihydroindene	15	12	5.0	3.2	3.9	4.1	N.D.*
115 Indene	42	37	6.9	3.5	4.1	5.0	N.D.
128 Naphthalene	400	420	<1**	<1**	<1**	<1**	N.D.
134 Benzo[b]thiophene	15	12	4.3	3.1	2.6	2.7	N.D.
129 Quinoline	<1	<1	<1	<1	<1	<1	N.D.
142 2-methylnaphthalene	560	440	<1**	1.8	<1**	<1**	N.D.
117 Indole	<1	<1	<1	<1	<1	<1	N.D.
142 1-methylnaphthalene	310	260	25	14	9.2	9.4	N.D.
154 1,1'biphenyl	120	86	7.6	4.7	3.4	3.7	N.D.
152 Acenaphthylene	390	230	18	8.4	5.7	6.1	N.D.
154 Acenaphthene	320	170	22	13	8.6	9.5	N.D.
166 Fluorene	530	490	28	17	9.0	10.1	N.D.
178 Phenanthrene	2,500	2,100	38	21	7.6	8.2	N.D.
178 Anthracene	590	460	17	10	2.8	3.2	N.D.
9 Acridine	29	18	3.3	1.8	<1**	1.0	N.D.
179 Phenanthridine	34	25	1.6	<1**	<1**	<1**	N.D.
167 Carbazole	28	18	<1**	<1**	<1**	<1**	N.D.
202 Fluoranthene	1,700	1,400	46	21	7.6	8.1	N.D.
202 Pyrene	1,500	1,200	38	18	6.5	6.8	N.D.
228 Benz[a]anthracene	680	460	15	8.0	2.3	2.4	N.D.
228 Chrysene	580	420	12	6.4	3.0	3.0	N.D.
252 Benzo[b]fluoranthene	530	330	9.7	5.6	2.6	2.8	N.D.
252 Benzo[k]fluoranthene	330	300	7.1	4.1	2.4	2.4	N.D.
252 Benzo[e]pyrene	310	280	6.4	3.4	1.7	1.8	N.D.
252 Benzo[a]pyrene	570	450	11	6.2	2.5	2.5	N.D.
252 Perylene	85	80	2.2	1.8	<1**	<1**	N.D.
276 Indeno[1,2,3 CD]anthracene	290	200	6.4	2.9	1.7	1.6	N.D.
278 Dibenz[a,h]anthracene	81	43	2.0	1.6	<1**	<1**	N.D.
276 Benzo[g,h,i]perylene	310	190	5.9	3.1	1.5	1.5	N.D.

All values in μg/L (PPB)

* N.D. - None Detected
Detection Limit 1 μg/L
Compound detected but below quantitation limits
(Samples at Time 0:00 and 0:30 contained large amounts of sediment.)

9626725

11/24/82
N.

545 Indian Mound
Wayzata, Minnesota 55391
(612) 473-4224

November 24, 1982

Mr. Mike Hansel
Regulatory and Compliance Section
Solid Land Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B-2
Roseville, MN 55113

Re: St. Louis Park Well Abandonment Program

Dear Mr. Hansel:

Enclosed herewith please find one (1) copy of the qualitative and quantitative results of the sample taken from Well 23 on October 28, 1982.

If you have any questions please feel free to contact me at 473-4224.

Sincerely,

EUGENE A. HICKOK AND ASSOCIATES

George W. Boyer
bt

George W. Boyer, P.E.
Vice President

bt

Enclsoure

9626713

The University of Iowa
Iowa City, Iowa 52242

University Hygienic Laboratory
(319) 353-5990

RECEIVED NOV 2 2 1982

19 November 1982

E. A. Hickok and Associates
545 Indian Mound
Wayzata, MN. 55391

Attn: Mr. Paul Josephson

Dear Paul:

Attached are the qualitative and quantitative results from the samples submitted on 1 November 1982.

Sincerely,

Armand F. Lange, Ph.D.

Armand F. Lange, Ph.D.
Chief, Organic Analytical Division

mrw

Enclosure

cc: Dr. Splinter
Dr. Hahne
Ms. Cain
Mr. Brewer
File

9626714

UNIVERSITY HYGIENIC LABORATORY

EUGENE A HICKOK IDENTIFICATION Q m/e Compound		OW23 10" casing 10/28/82 Time O UHL# 2-4079 ug/L	Blank ug/sample
117	2,3-Dihydroindene	220	<1
115	Indene	280	<1
128	Naphthalene	2600	<1
134	Benzo[b]thiophene	160	<1
129	Quinoline	<20 *	<1
142	2-Methylnaphthalene	2500	<1
117	Indole	<20 *	<1
142	1-Methylnaphthalene	1600	<1
154	1,1'-Biphenyl	450	<1
152	Acenaphthylene	200	<1
154	Acenaphthene	1600	<1
166	Fluorene	1700	<1
178	Phenanthrene	4000	<1
178	Anthracene	900	<1
179	Acridine	100	<1
179	Phenanthridine	30	<1
167	Carbazole	230	<1
202	Fluoranthene	1500	<1
202	Pyrene	1300	<1
228	Benz[a]anthracene	400	<1
228	Chrysene	530	<1
252	Benzo[b]fluoranthene	400	<1
252	Benzo[k]fluoranthene	330	<1
252	Benzo[e]pyrene	280	<1
252	Benzo[a]pyrene	470	<1
252	Perylene	70	<1
276	Indeno[1,2,3 cd]pyrene	190	<1
278	Dibenz[a,h]anthracene	210	<1
276	Benzo[g,h,i]perylene	260	<1

*High detection limits due to presence of large amounts of other compounds

9626715

UNIVERSITY HYGIENIC LABORATORY

E.A. Hickok Identification

OW23 10" casing 10/28/82 Time 0

UHL # 2-4080

Compounds Identified

2,3-Dihydroindene
Indene
Naphthalene
Benzo[b]thiophene
2-Methylnaphthalene
1-Methylnaphthalene
1,1'-Biphenyl
Acenaphthylene
Acenaphthene
Fluorene
Phenanthrene
Anthracene
Acridine
Phenanthridine
Carbazole
Fluoranthene
Pyrene
Benz[a]anthracene
Chrysene
Benzo[b]fluoranthene
Benzo[k]fluoranthene
Benzo[j]fluoranthene
Benzo[e]pyrene
Benzo[a]pyrene
Perylene
Indeno[1,2,3 cd]pyrene
Dibenz[a,h]anthracene
Benzo[g,h,i]perylene
Ethylbenzene
Dimethylbenzenes (xylenes)
Ethenylbenzene
Nonane
Methylethylbenzene
Propylbenzene
Dimethylnonane
Methyl-ethylbenzenes

Methylcyclodecane
Trimethylbenzene
Methyldecane
Ethyl-dimethylbenzenes
Methyl-2,3-dihydroindenes
Undecane
Ethenyl-dimethylbenzenes
Phenylpropenal
Tetramethylbenzenes
Tetramethylpentane
Trimethyloctane
Dimethyldecanes
Hydroxybenzaldehyde
Methylphenols
Ethylphenols
Dimethylphenols
Methylindene
Methoxybenzaldehyde
Trimethylphenols
Ethyl-methylphenols
Hydroxybenzoic Acid
Isofurandione
Diethylphenol
Ethylnaphthalenes
Dimethylnaphthalenes
Dimethylbenzofuran
Cyclopentylbenzene
Dihydromethylnaphthalenes
Dimethyl-2,3-dihydroindene
Tridecane
Methylethylnaphthalene
Trimethylnaphthalenes
Methyl-1,1'-biphenyl
Methyldibenzofuran
Dibenzofuran
2,3 Dihydroindenediol

Biphenylene
Methylphthalazinone
Naphthalenol
Methylnaphthalenols
[1,1'biphenyl]-ols
Dimethylnaphthol
Dibenzofuranol
Methoxy-1,1'-biphenyl
Methyl-phenoxybenzene
Dibenzodioxins
Methyldibenzothiophenes
Methylphenanthrenes
Methylpyridoindolols
Dimethylnaphthothiophene
Dimethylethyl-[1,1'biphenyl]-ol
Methylphenylcinnolines
Methylbenzo[c]cinnoline
Phenanthrenol
Benzofluorenes
Dimethylbenzo[c]cinnolines
Dimethyl-1,1'-biphenyl
Methylfluorenes
Dihydromethylbenzofuran
Phenylnaphthalenes
Methylphenanthrenes
Dimethylphenanthrenes
Ethylphenanthrene
Phenanthroimidazole
Methylpyrenes
Terphenyls
Benzo[b]naphthothiophenes
Cyclopentaphenanthrene
Methyltriphenylenes
Binaphthalenes
Dimethylbenzo[c]phenanthrene
Methylbenz[j]aceanthrylenes

11/82 N.

Attachment 1

SUMMARY OF BORINGS AND PIEZOMETER INSTALLATION BY GCA CORPORATION/TECHNOLOGY DIVISION - REILLY TAR SITE, ST. LOUIS PARK, MINNESOTA

No.	Designation: Elevation of L.S. (MSL)	Designation	Location	Type	Date completed	Piezometer	Perforated interval depth below L.S.	Total depth below L.S.	Depth to bedrock below L.S.	Drilling method	Sample type	No. of samples	Distance into bedrock	Depth over 60 ft	Comments
1	908.88	(ST1 (old)) PB136	36th St & Minnehaha Creek	Clean Background Location	10/25/82	Yes	89.3' to 92.3'	93.5'	87.5'	Drive and wash	SS[a] ST[b]	21 0	6'	33.5'	Screen in bedrock
2	909.14	PB137	36th St & Minnehaha Creek; 40' E of PB136	Clean Background Location	10/28/82	Yes	82.3' to 85.3'	86.5'	85.0'	Drive and wash	SS ST	2 6	1.5'	26.5'	Cleared utilities
3	907.46	PB138	34th St & Xylon/Wyoming (next to water tower)	Clean Background Location	11/2/82	Yes	63.5' to 66.5'	78.5'	77.8'	Drive and wash	SS ST	17 2	~~1.5'~~ 7'	18.5'	Cleared utilities
4	893.67	PB139	Dead end of Quebec at 31 St	Reilly Tar Site Solid Ground	11/4/82	Yes	59.0' to 62.0'	67.5'	63.5'	Drive and wash	SS ST	16 1	4'	7.5'	Cleared utilities
5	893.~~60~~ 35	PB140	Louisiana Av. next to W23	Reilly Tar Site Solid Ground	11/10/82	Yes	65.7' to 68.7'	71.0'	≈70.0'	Drive and wash	SS ST	17 1	1'	10'	Cleared utilities
6	890.11	PB142	Walker Av. & Louisiana Av. Ext.	Reilly Tar Site Solid Ground	11/12/82	No	-	64'	63.7'	Augered	SS ST	14 1	-	4'	Cleared utilities
7	914.00	PB141	On Highway 7 overpass west of Louisiana Av. exit	Reilly Tar Site Solid Ground	11/15/82	No	-	65'	-	Augered	SS ST	13 0	-	5'	Roadway signs special materials
8	895.~~41~~ 82	PB144	Filled Swamp S of Highway 7 164' W of W13	Reilly Tar Site Solid Ground	11/19/82	Yes	44.3' to 47.3'	59'	51'(?)	Drive and wash	SS ST	13 1	8'	-	Cleared utilities

[a]Split Spoon Sampler.

[b]Thin wall Shelby Tube Sampler.

Attachment 2

SUMMARY OF PAH ANALYSIS AT REILLY TAR SITE FOR SAMPLES TAKEN DURING OCTOBER-NOVEMBER 1982 BY GCA/TECHNOLOGY DIVISION

Sample No./Type

Compound	FB-136(ST-1) #3 fibrous peat @ ≈ 5' bls	FB-136(ST-1) #4 nonfibrous peat @ ≈ 7' bls	FB-136(ST-1) #5 nonfibrous peat @ ≈ 8' bls	FB-136(ST-1) #6 gray till @ ≈ 13' bls	FB-136(ST-1) #10 outwash @ ≈ 33' bls	FB-136(ST-1) #18 gray till @ ≈ 73' bls	FB-136(ST-1) #19 sand @ ≈ 78' bls	FB-136(ST-1) #20 sand @ ≈ 83' bls	FB-136(ST-1) #22 weathered bedrock @ ≈ 87' bls
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acridine	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbazole	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a) anthracene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b) fluoranthene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a) pyrene	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h) anthracene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*

Compound	FB-138 #3 brown sand @≈5' bls	FB-138 #7 gray till @≈19' bls	FB-138 #10 outwash @≈34' bls	FB-138 #12 outwash @≈44' bls	FB-138 #16 outwash @≈46' bls	FB-138 #18 lacustrine clay @≈74' bls	FB-139 #4 fibrous peat @≈3' bls	FB-139 #9 outwash @≈24' bls	FB-139 #10 gray till @≈29' bls	FB-139 #16 outwash @≈59' bls
Naphthalene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthylene	0.49	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	1.3a	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	-	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acridine	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbazole	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	1.3	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	1.1	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a) anthracene	0.87	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(b) fluoranthene	1.1a	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a) pyrene	0.42	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h) anthracene	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*

ND = 0.5 mg/kg 0.2 mg/kg →

ND* = 2.0 mg/kg 0.8 mg/kg →

Concentrations in mg/kg

aReported value is total concentration of the two coeluting compounds.

Compound	FB-140 #2 black sand @≈5'bls	FB-140 #3 black/ brown sand @ ≈ 5' bls	FB-140 #4 brown sand @≈9'bls	FB-140 #6 silty clay @≈14'bls	FB-140 #14 outwash @≈49'bls	FB-140 #16 outwash @≈59'bls	B-141 #2 fill @≈8'bls	B-141 #3 fill @≈13'bls	B-141 #7 fibrous peat @≈28'bls	B-141 #8 nonfibrous peat @ ≈ 38' bls	B-141 #9 grey till @≈44'bls	B-141 #11 outwash @≈54'bls	B-142 #5 outwash @≈14'bls	B-142 #7 outwash @≈24'bls	B-142 #9 outwash @≈34'bls	B-142 #11 outwash @≈44'bls	B-142 #12 red till @≈49'bls	B-142 #13 red till @≈54'bls	B-142 #14 outwash @≈59'bls
Naphthalene	400	4.4	1.2	110	ND	ND	ND	ND	ND	ND	ND	ND	0.23	ND	ND	0.23	ND	0.37D	0.37
Acenapthylene	58	0.53	ND	0.47	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acenaphthene	120	0.63	ND	62	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluorene	350	2.1	ND	43	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Phenanthrene	910[a]	10.5[a]	0.79[a]	160[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Anthracene	-	-	-	-	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Acridine	ND	ND	ND	2.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Carbazole	66	0.54	ND	4.0	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fluoranthene	600	6.7	0.63	73	ND	ND	0.23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Pyrene	480	5.1	0.36	51	ND	ND	0.21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a) anthracene	460	4.0[a]	0.36[a]	32	ND	ND	0.28	ND	ND	ND	ND	0.29[a]	ND	ND	ND	ND	ND	ND	ND
Benzo(k) fluoranthene	300[a]	2.3	ND	14[a]	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Benzo(a) pyrene	210	1.3	ND	5.6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
Dibenzo(a,h) anthracene	43	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*	ND*

ND = 0.2 mg/kg ⟶ 0.5 mg/kg 0.2 mg/kg ⟶

ND* = ⟶ 0.8 mg/kg ⟶ 2.0 mg/kg 0.8 mg/kg ⟶

Concentrations in mg/kg

[a]Reported value is total of the two coeluting compounds.

Compound	Sample No./Type			
	PB-144 #2	PB-144 #3	PB-144 #5	PB-144 #7
	top soil @≈8'bls	fibrous peat @≈14'bls	nonfibrous peat @ ≈ 19' bls	outwash @≈29'bls
Naphthalene	1.2	3.4	ND	6.6
Acenapthylene	ND	0.73	ND	ND
Acenaphthene	0.24	0.46	ND	0.65
Fluorene	0.24	0.50	ND	0.45
Phenanthrene	1.1[a]	4.8[a]	ND	0.93
Anthracene	-	-	ND	-
Acridine	ND	0.28	ND	ND
Carbazole	ND	0.53	ND	0.24
Fluoranthene	0.53	4.3	ND	ND
Pyrene	0.40	3.8	ND	ND
Benzo(a) anthracene	0.34[a]	6.2	ND	ND
Benzo(k) fluoranthene	ND	11.7[a]	ND	ND
Benzo(a) pyrene	ND	14.5	ND	ND
Dibenzo(a,h) anthracene	ND*	1.5	ND*	ND*
ND =	0.2 mg/kg	-----	0.5 mg/kg	0.2 mg/kg
ND* =	0.8 mg/kg	-----	2.0 mg/kg	0.8 mg/kg

Concentrations in mg/kg

[a]Reported value is total of the two coeluting compounds.

Attachment 3

PRELIMINARY SUMMARY OF PHYSICAL TESTING RESULTS AT REILLY TAR SITE FOR SAMPLES TAKEN DURING OCTOBER-NOVEMBER 1982 BY GCA/TECHNOLOGY DIVISION

	PB 137			PB 138		PB 139	PB 140	PB 142	PB 144
Test	#1/4'-5' non-fibrous peat	#5/8'-10.5' till	#6/10.5'-13' till	#5/8'-10.5' lac. clay	#13/48'-50' DM outwash	#8/20'-22.5' lac. clay	#5/8'-10.5' lac. clay	#3/4'-6.5' DM outwash	#4/15'-17.5' fibrous peat
K_v (ave.)	7.4×10^{-7}	3.5×10^{-7}	2.1×10^{-7}	7.2×10^{-8}	-	7.6×10^{-8}	-	-	1.2×10^{-7}
K_h	-*	-	-	-	-	-	-	-	-*
Porosity (%)	-*	28	28	39	-	45	-	-	-*
Particle Size	0% gravel 41% sand 55% silt 4% clay	4.7% gravel 49.7% sand 28.1% silt 17.5% clay	2.2% gravel 53% sand 27.1% silt 17.5% clay	1.3% gravel 35.1% sand 44.1% silt 19.5% clay	0% gravel 14.6% sand 75.4% silt 10% clay	0% gravel 15% sand 60% silt 25% clay	-	-	-*
TOC	190,000 mg/kg	2,500 mg/kg	2,100 mg/kg 2,800 mg/kg	3,400 mg/kg	900 mg/kg	6,600 mg/kg	7,600 mg/kg	-	110,000 mg/kg

*Test in progress.

Attachment 4

GCA BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 of 2	PB136

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Background: 36th & Minnehaha	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft)	TOTAL DEPTH
10/18	10/25	Braun Engr	CME-75	4"	87.5	6	93.5'

CORE RECOVERY (ft, %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	21	910.53	908.88	8.6'/900.28	87.5/821.38

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈95'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION 908.88	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
SS/2.5"	2'	6"	11	2	3	3	5			1	0-4'. Topsoil, organic, roots, and grass.	Mud & cuttings discharged to creek as OK by Mike Hansel; standpipe with 2.65' stickup. Water table ≈8.6'. Operation start @ 11:00. SS sampler is 2.5" ID and the tip is flush inside.	-
SS	2'	12"	13	3	3	4	6	904.88		2			
SS	2'	14"	10	2	2	4	4	902.88 902.38	5	3	4'-6'. Brown fibrous peat. 6'-6.5'. Black nonfibrous peat.		3
SS	2'	20"	10	2	1	4	5	900.88		4	6.5'-8'. Med. to coarse sand with organic rich S/C zones.		4
SS	2'	24"	11	4	4	4	3	899.38 898.88		5	8'-9.5'. Nonfibrous peat.		5
									10		9.5'-10'. Outwash sand.		
SS	2'	23.6"	35	9	11	11	13			6	10'-26'. Gray till. Very fine silty clay with scattered pebbles of limestone, sandstone (red) and mafic rocks.		6
									15				
SS	2'	23.2"	38	4	10	12	16			7			-
									20				
SS	2'	18"	33	6	9	12	12			8			-
									25				
NS	2'	0	50	12	16	17	17	882.88		9	26'-38'. Coarse outwash. Coarse sand (reddish/brown) fine fine to medium gravel of red sandstone, limestone, and basaltic rocks, and rock fragments.		-
									30				
SS	2'	0.7'	47	10	14	23	10			10			10
									35				
SS	2'	2'	57	15	21	16	20	870.88		11	38'-51.5'. Gray till. Similar in texture to above till layer. A few oxidized S/C rich layer (thin) are observed.		-
									40				
SS	2'	4"	94	21	19	32	43			12			-
									45				

SS: SPLIT SPOON; ST: SHELBY TUBE; D: DENNISON; P: PITCHER; O: OTHER	SITE	HOLE NO.
	Background: 36th & Minnehaha	PB136

FORM 1003A

BORING LOG

PROJECT	JOB NO	SHEET NO	HOLE NO.
Reilly Tar	1-619-078	2 OF 2	PB136

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
SS	2'	3"	77	20	26	21	30			13		Reduced sampler tip to specs.	-
								857.38	50				
SS	2'	9.5"	120	35	38	38	44			14	51.5'-56'. Outwash sand. Medium sand; quartz, feldspars and rock fragments, fine gravel of mafic rocks.		-
								852.88	55				
SS	2'	9"	55	16	18	16	21			15	56'-66'. Gray till similar in texture and composition to above till layers.		-
									60				
SS	2'	0	171	21	41	55	75			16			-
								842.88	65				
SS	2'	0	301	44	80	126	95			17	66'-71'. Medium sand, poorly sorted, with fine gravel.		-
								837.88	70				
SS	2'	0.85'	153	36	44	46	63			18	71'-76.5'. Gray till similar in texture and composition as above till layers.		18
								832.38	75				
SS	2'	1.85'	173	35	45	64	64	830.38		19	76.5'-78.5'. Sand matrix with fine gravel.		19
								827.38	80		78.5-81.5'. Gray till similar in texture and composition as above till layers.		
SS	2'	0.8'	225	19	60	86	79			20	81.5-87.5'. Reddish/brown medium sand matrix with pebbly gravel.		20
									85				
SS	1'	1'	180	21	180	-	-	821.38		21	87.5'-93.5'. Weathered limestone bedrock.	Loss of all washing and mud @ 87.5'.	21
									90				
								815.38			Bottom of hole.		

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Background: 36th & Minnehaha

HOLE NO. PB136

FORM 10038

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly TAR 1-619-078

SITE Background clean location 36th & Minnehaha

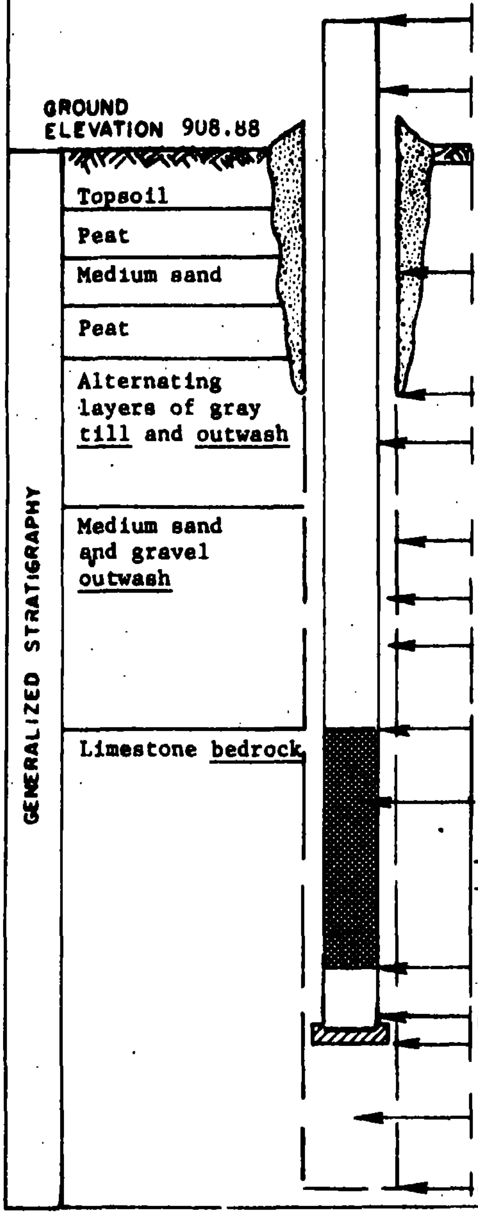
COORDINATES

DATE COMPLETED 10/25/82

SUPERVISED BY P.Huidobro

WELL NO. PB136

AQUIFER Platteville Limestone



Elevation of reference point	910.53
Height of reference point above ground surface	1.65
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: steel with vented locking cap	
Depth of surface casing	5.35'
I.D. of riser pipe	2"
Type of riser pipe: galvanized 10.5 section	
Diameter of borehole	4"
Type of filler: cement/bentonite 1:1	822.88/86'
Elevation / depth of top of seal	
Type of seal: 6/1 cement/bentonite	
Type of gravel pack No. 20 silica sand	
Elev./depth of top of gravel pack	821.38/87.5'
Elevation / depth of top of screen	819.58/89.3'
Description of screen 3'x2" welded slot No. 10 galvanized steel	
I.D. of screen section	
Elevation / depth of bottom of screen	816.58/92.3'
Elev./depth of bottom of ~~gravel pack~~ bentonite	816.58/92.3'
Elev./depth of bottom of plugged blank section	815.38/93.5'
Type of filler below plugged section bentonite	
Elevation of bottom of borehole	815.38/93.5'

GCA CORPORATION
Technology Division

FORM 1002

BORING LOG

GCA

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB137

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Background: 36th & Minnehaha	located approximately 30' N of PB136	90°	–

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
10/26	10/28	Braun Engr	CME-75	4"	85.0	1.5	86.5'

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
–	–	8	910.9	909.14	8.7'/900.44'	85/824.14

SAMPLE HAMMER WEIGHT / FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈90'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	LAB SAMPLE NO.
									909.14					
SS/ 2.5"	2'	0.7'	14		2	4	5	5			1	0-3'. Topsoil with grass and roots and pebbles.		–
SS	2'	0.8'	14		4	5	4	5	906.14		2			–
ST	1'	1'								5	3	3'-7.5'. Fibrous peat.	ST = 3" x 30"	3*
ST	2.5'	0									4			4*
ST	2.5'	2.5'							▽	10	5	7.5'-11.5'. Top and bottom of sampler show gray clays.	Water table @≈8'	5*
ST	2.5'	2.5'							897.64		6	11.5'-25'. Gray till. Assumed from log of borehole PB136.	Washings are uniform throughout the rest of the hole. Showing fine gravels and some gray S/C. Very little sand.	6*
									884.14	15, 20, 25				
ST	0	0								30	7	25'-37.5'. Coarse outwash. Assumed same stratigraphy as borehole PB136.		–
									871.64	35				
										40, 45		37.5'-51.5'. Gray till. Assumed same stratigraphy as borehole PB136.	*Sample for physical measurement only	

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	Background: 36th & Minnehaha	PB137

FORM 1003A

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	2 OF 2	PB137

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN	SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
											857.64	50				
											853.14	55		51.5'-56'. Outwash sand. Assumed same stratigraphy as borehole PB136.		
											843.14	60, 65		56'-66'. Gray till. Assumed same stratigraphy as borehole PB136.		
											838.14	70		66'-71'. Medium sand. Assumed same stratigraphy as borehole PB136.		
											832.64	75		71'-76.5'. Gray till. Assumed same stratigraphy as borehole PB136.		
											830.64			76.5'-78.5. Sand and gravel. Assumed from borelog PB136.		
											824.14	80		78.5'-85'. Gray till. Assumed same stratigraphy as PB136.		
ST	1'		1'								822.64	85	8	85'-86.5'. Bedrock. Weathered limestone.	Loss of H_2O & mud. Roller bit to 86.5' is difficult and jumpy. No washings are recovered.	8*
												90		Bottom of hole		

SS: SPLIT SPOON; ST: SHELBY TUBE
D: DENNISON; P: PITCHER; O: OTHER

SITE Background: 36th & Minnehaha

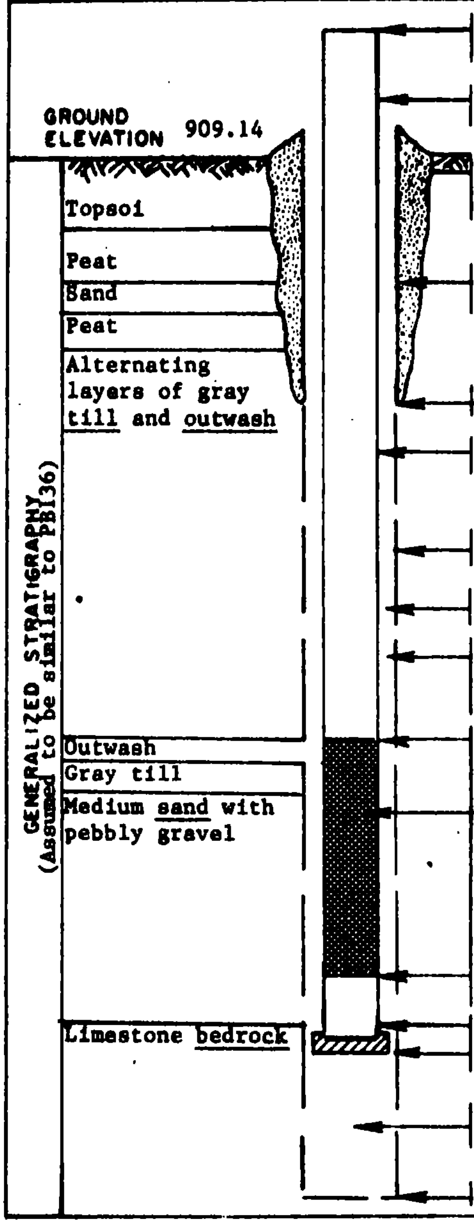
HOLE NO. PB137

FORM 1003B

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly TAR
SITE 36 & Minnehaha
COORDINATES -
DATE COMPLETED 10/27/82
SUPERVISED BY P. Huidobro

WELL NO. PB137
AQUIFER Glacial Drift



Elevation of reference point	910.9
Height of reference point above ground surface	1.76
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: steel with vented locking cap	
Depth of surface casing	5.24'
I.D. of riser pipe	2"
Type of riser pipe: galvanized steel	
Diameter of borehole	4"
Type of filler: 1/1 cement/bentonite	
Elevation / depth of top of seal	834.54/74.6'
Type of seal: 1/1 cement/bentonite	
Type of gravel pack silica sand No. 20	
Elev./depth of top of gravel pack	833.54'/75.6'
Elevation / depth of top of screen	826.84'/82.3'
Description of screen No. 10 slot welded galvanized steel	
I.D. of screen section	
Elevation / depth of bottom of screen	822.64'/86.5'
Elev./depth of bottom of gravel pack	822.64'/86.5'
Elev./depth of bottom of plugged blank section	822.64'/86.5'
Type of filler below plugged section	
Elevation of bottom of borehole	822.64'/86.5'

GCA CORPORATION Technology Division

FORM 1002

BORING LOG

GCA

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB138

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
34th & Xylon-Wyoming	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft)	TOTAL DEPTH
10/29	11/2/82	Braun Engr	CME-75	4"	77.8	0.7	78.5'

CORE RECOVERY (ft./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
140#/30"	-	19	909.77'	907.46'	-	77.8'/829.66'

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈80'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN	SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION 907.46	DEPTH, ft	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	LAB SAMPLE NO.
SS/2.5"	2'		1.2'		26		4	7	8	11				1	0-4'. Topsoil. Sand and pebbles, roots, grass, and gray clay.	Drilling, uninterrupted using method of sampling ahead of the casing; RB 3' and driving casing 5' supply of mud is continuous now, due to use of a Longyear mud mixer. Operation goes faster and without problem	-
SS	2'		0.8'		30		12	9	9	12	903.46			2			-
SS	2'		0.6'		21		6	7	8	6	900.96	5		3	4'-6.5'. Brown sand, mostly quartz, chunks of tar; oxidized S/C zones.		3
SS	2'		1.5'		20		4	5	8	7	900.46			4	6.5'-7.0'. Fibrous peat.		-
ST/3.0"	2.5'		1.8'		-		-	-	-	-	896.96	10		5	7.0'-10.5'. Black/brown nonfibrous peat.		5*
															10.5'-14.5'. Poorly sorted sand with fine gravel. Mostly quartz and feldspar.		
SS	2'		1'		44		16	12	14	18	892.96			6			-
												15			14.5'-30'. Gray till. Dense, fine silt and clay. Pebbles of limestone, angular, and rounded mafic rocks; red sandstone and agate (red). Yellow/brown oxidation zones at the top.		
SS	2'		1.8'		23		4	6	7	10		20		7			7
SS	2'		1.7'		35		7	8	11	16		25		8			-
SS	2'		1.8'		49		23	11	17	21	877.46	30		9			-
															30'-34'. Coarse gravel of weathered limestone, olivine basalt, red sandstone and granitic rocks.		
SS	2'		1'		290		80	66	90	134	873.46			10			10
												35			34'-64'. Outwash sand. Brown, moderate to well sorted. Mostly quartz, agate, and mafic minerals, some orthoclase. Grain size increases with depth. Thin, very dense silt and clay layers observed at 53' and 59.5'.		
SS	2'		2'		147		50	49	45	53		40		11			-
SS	2'		1.5'		178		55	59	56	63		45		12		*Sample for physical measurements only.	12

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	34th & Xylon/Wyoming	PB138

FORM 1003A

BORING LOG

PROJECT	JOB NO	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	2 OF 2	PB138

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
SS	30"	24"	-		-	-	-	-		50	13			-
SS	2'	16"	315		84	127	100	88		55	14			-
SS	2'	1.5'	417		83	104	100	213		60	15			-
SS	2'	1.5'	167		55	47	54	66	843.46	65	16	64'-67.5'. Medium to coarse outwash sand and fine gravel with thin layers of silt and clay.		16
									839.96					
SS	2'	1.5'	86		28	29	30	27		70	17	67.5'-75'. Gray clay, dense, with very fine lenses of fine sand. Large rafted pebbles of basaltic composition.		-
SS	2'	14"	64		23	23	19	22	832.46	75	18			18
									829.66			75'-77.8'. Coarse sand with chips of weathered limestone.		
SS	3"	0	-		300	-	-	-	828.96	80	19	77.8'-78.5'. Bedrock, weathered limestone. Bottom of hole. 78.5'.	No loss of H_2O at bedrock contact. Washings from 8.0' come out with fine sand and large LS chips.	-

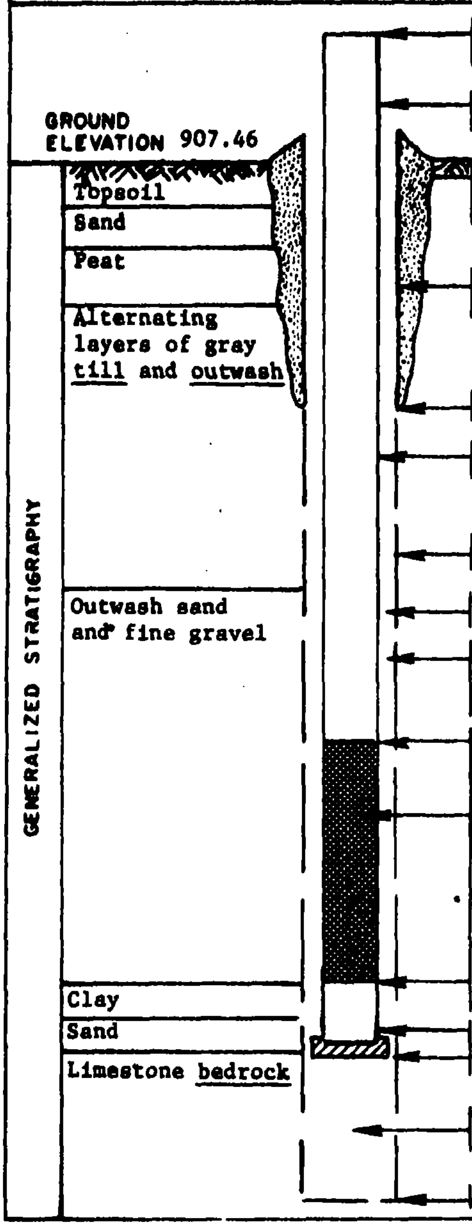
SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER	SITE 34th & Xylon/Wyoming	HOLE NO. PB138

FORM 1003B

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT: Reilly TAR
SITE: 34th & Xylon/Wyoming
COORDINATES: -
DATE COMPLETED: 11/2/82
SUPERVISED BY: P. Huidobro

WELL NO.: PB138
AQUIFER: Glacial Drift



Elevation of reference point	909.77
Height of reference point above ground surface	1.81
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: steel	
Depth of surface casing	5.19'
I.D. of riser pipe	2"
Type of riser pipe: galvanized steel, coupled	
Diameter of borehole	4"
Type of filler: cement/bentonite 1:1	
Elevation / depth of top of seal	849.96/57.5'
Type of seal: 6:1 cement/bentonite	
Type of gravel pack silica sand #20	
Elev./depth of top of gravel pack	848.16/59.3'
Elevation / depth of top of screen	843.96/63.5'
Description of screen No. 10 slot welded galvanized steel	
I.D. of screen section	2"
Elevation / depth of bottom of screen	840.96/66.5'
Elev./depth of bottom of gravel pack	835.46/72'
Elev./depth of bottom of plugged blank section	828.96/78.5'
Type of filler below plugged section bentonite	
Elevation of bottom of borehole	828.96/78.5'

GCA CORPORATION
Technology Division

FORM 1002

GCA BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 of 2	PB139

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
31st & Quebec	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
11/3	11/4/82	Braun Engr.	CME75	4"	63.5	4.0	67.5'

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	17	896.45	893.67	-	64'/829.67

SAMPLE HAMMER WEIGHT / FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈70'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN	SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	LAB SAMPLE NO.
											893.67						
SS 2.5"	2'		14"		29		3	7	11	11				1	0-6'. Topsoil. Organic rich, roots and oxidized zones. Coarse sand and gravel. Bioturbated.	Continuous sampling for top 10', after which samples are taken ahead of the H casing, after RB and introduction of casing. Safety considerations are applied as per contract requirements because site is suspected to be contaminated. No contamination by oil or creosote is observed in the RB washings and cuttings.	-
SS	2'		1.2'		49		8	15	15	19				2			-
SS	2'		2'		60		12	16	20	24	887.65	5		3			-
SS	2'		1.5'		11		3	3	3	5				4	6'-18'. Thin layer (3") of fibrous peat followed by black, nonfibrous peat, strong decomposition odor.		4
SS	2'		1.5'		7		0	2	2	3				5			-
												10					
SS	2'		0		13		5	4	4	5				6			-
											875.67	15					
SS	2'		14"		7		1	2	2	3		20		7	18'-21.5'. Lacustrine clayey silt with thin lenses of fine sand.		-
ST/30"	30"		30"								872.17 871.67			8	21.5'-22'. Medium sand.		8
											869.97				22'-23.7'. Silty clays.		
SS	2'		14"		47		13	15	20	12	868.67	25		9	23.7'-25'. Outwash sand with <1% gravel.		9
SS	2'		1.5'		52		13	11	17	24		30		10	25'-34.5'. Gray till. Fine sand in a S/C matrix with gravel of granitic and mafic rocks, and limestone. Red/brown oxidized zones interlayered.		10
SS	2'		1'		66		22	21	20	25	859.17	35		11			-
SS	2'		0		48		23	18	15	15		40		12	34.5'-64'. Outwash sand and gravel. Sand fraction is brown, fine to coarse consisting mostly of quartz and rock fragments. Fine to coarse gravel of both gravimitic and mafic rocks mixed with limestone and red sandstone. A one-inch layer of red till is observed at the bottom of the outwash layer in contact with the limestone bedrock.	Character of washings at the interval where no samples are recovered are consistent with those above and below those	-
SS	2'		0		72		28	27	20	25		45		13			-

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE 31st & Quebec	HOLE NO. PB139

FORM 1003A

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	2 OF 2	PB139

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
SS	2'	1'	73	19	26	22	25		50	14		intervals. Core catcher replaced after sample # 13. Samples 15 & 16 are impossible to extrude from liners, possibly due to highly cohesive fine sands. @ 64', RB's jumpy and hydraulic pressure 800 lb. Washing contains checks of weathered limestone.	-
SS	2'	4"	117	33	38	38	41		55	15			-
SS	2'	1'	153	40	46	52	55		60	16			16
SS	0.5'	0		200	-	-	-	829.67	65	17	64'-67.5'. <u>Bedrock</u>. Limestone.		-
								826.17			Bottom of hole.		
									70				

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: 31st & Quebec

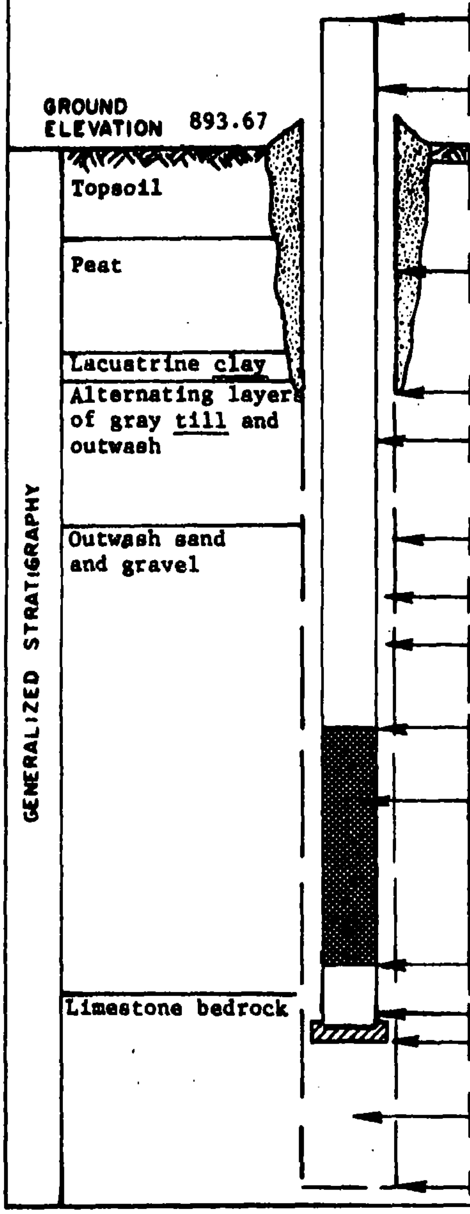
HOLE NO. PB139

FORM 10088

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly Tar
SITE 31st & Quebec
COORDINATES -
DATE COMPLETED 11/5/82
SUPERVISED BY P. Huidobro

WELL NO. PB139
AQUIFER Glacial Drift



Elevation of reference point	896.45
Height of reference point above ground surface	2.78'
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: steel 7'x4"	
Depth of surface casing	4.22'
I.D. of riser pipe	2"
Type of riser pipe: coupled glavanized steel	
Diameter of borehole	4"
Type of filler: 1:1 cement/bentonite	
Elevation / depth of top of seal	838.67/55'
Type of seal: 6:1 cement/bentonite	
Type of gravel pack silica sand	
Elev./depth of top of gravel pack	837.17/56.5'
Elevation / depth of top of screen	834.67/59.0'
Description of screen No. 10 slot welded steel	
I.D. of screen section	2"
Elevation / depth of bottom of screen	831.67/62.0'
Elev./depth of bottom of gravel pack	827.67/66.0'
Elev./depth of bottom of plugged blank section	826.17/67.5'
Type of filler below plugged section bentonite	
Elevation of bottom of borehole	826.17/67.5'

GCA CORPORATION
Technology Division

FORM 1002

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB140

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Louisiana Ave. Near W23	-	90°	- .

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft)	TOTAL DEPTH
11/8/82	11/10/82	BRAUN ENGR	CME 75	4"	70	1	71 ft.

CORE RECOVERY (ft./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	- .	18	895.99'	893.35'	-	70/823.60

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 #130	2"/≈ 73'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN	SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION 893.35'	DEPTH, ft	SAMPLE	LAB SAMPLE NO.
SS/2.5"	1.6'	1.5'			272		2	10	31	231	891.60		1	-
SS	2'	1.5'			126		105	53	38	35			2	2
SS	2'	1'			31		12	14	9	8	888.35	5	3	3
SS	2'	1.8'			21		6	5	7	9	885.35		4	4
ST	30"	18"										10	5	* 5
											881.85			
											880.35			
SS	2'	16"			34		14	11	11	12	877.35	15	6	6
SS	2'	1''			59		20	21	17	21		20	7	-
SS	2'	0			71		20	19	22	29		25	8	-
SS	2'	6"			45		16	15	16	14		30	9	-
SS	2'	o			55		19	20	18	17		35	10	-
SS	2'	0			100		18	22	32	46		40	11	-
SS	2'	0			111		49	32	34	45			12	-
SS	2'	4"			50		9	14	20	16		45	13	-

DESCRIPTION AND CLASSIFICATION

0-1.75'. Top Soil, brown sandy clay with roots and grass.

1.75'-5'. Well compacted black bituminous material. Gravelly sand all coated with black material. Tar smell. Material is very brittle

5'-8'. Coarse moderately sorted brown sand. Mostly qtz and rock frags red in color 1" layer of black sand (coated)

8'-11.5'. Very uniform layer of fibrous peat. Gray-black silty clay with gravel (4 cm). Strong farry smell.

11.5'-13'. Gray medium-fine sand, most qtz with some gravel, weathered LS and x-line rocks.

13'-16'. Very small silty clay gray on top and brown at bottom interlayered with coarse gravel. Till.

16'-65'. Outwash. Mod. sorted sand and fine gravel. It is not possible to determine its color because the grains appear to be saturated with very smelly "oily" fluid that covers all particles with an irridescent sheen. Mineralogy and petrology are tentative at best, mostly qtz and rock fragments. Gravel components are LS, red SS and xtaline rocks of basaltic nature as well as perthitic igneous rocks. Subporphyritic mafic rocks are also present. Phaneritic rocks of granitic composition with subhedral fabric. Gravel component decreases with depth and the sediment becomes better sorted in the medium to coarse sand range, which is about 90% qtz with little feldspars and rock fragments. Silt and clay content of this outwash is less than 10%.

48'-50' into the outwash consists of poorly sorted very fine to coarse sand; with <5% gravel and traces of silt and clay. Sand is reddish brown in color, and consists mostly of qtz with a larger component of red and black rock fragments and some red SS chips. Rock fragments are very angular and in general with a high sphericity value.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Using existing pit to dispose of cuttings and mud. Samples recovered from tarry layer are impossible to extrude from liners; they have to be scraped off. Washing from smelly zones come out with an irridescent oily film on top. HNU reading is 75 ppm.

Casing does not advance beyond 27; goes through. When pulled out drill pipe is chewed up, bit brings up a large chunk of jasper.

Cuttings from RB from 30'-55' consist of sand and broken gravel. Sand is fine and gravel is about 1 cm.

It is possible that this material is not held properly by the core catcher, or interfering with the ball valve on top, thus the samples are flushed out.

Left the site @ 16:30 after hitting bedrock heavy snow and hail/sleet.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE	HOLE NO.
Louisiana Ave. Near W23	PB140

FORM 1003A

	BORING LOG	PROJECT Reilly Tar	JOB NO. 1-619-078	SHEET NO. 2 OF 2	HOLE NO. PB140

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	LAB SAMPLE NO.
SS	2'	0.5	65	18	29	18	18		50	14	14
SS	2'	0	122	34	43	41	38		55	15	-
SS	2'	10"	54	21	22	17	15		60	16	16
SS	2'	10"	122	24	31	59	32		65	17	-
SS	1.5'	0.5'	192	50	40	152		823.35		18	-
								822.35	70		
									75		

DESCRIPTION AND CLASSIFICATION

58'-60'. Outwash zone with mineralogy and petrology similar to overlying zone. Well sorted medium sand 90% qtz 10% feldspars and fragments or mafic rx and red SS. Traces of S/C. No gravel.

63'-65'. Outwash is poorly sorted very fine to coarse brown sand with about 5% gravel.

65'-70'. Red/brown till in contact with bedrock. This unit is composed of 70% very fine sand, 25% silt and clay and 5% medium gravel. Fine portion is mostly qtz while pebbles are of mafic rock, and LS, angular to rounded. Unstratified.

Bedrock - Bottom of hole.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC

*Sample for physical measurements only

SS = SPLIT SPOON; ST = SHELBY TUBE
D = DENNISON; P = PITCHER; O = OTHER

SITE Louisiana Ave. Near W23

HOLE NO. PB 140

FORM 10038

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly Tar

SITE Louisiana Ave. next to W23

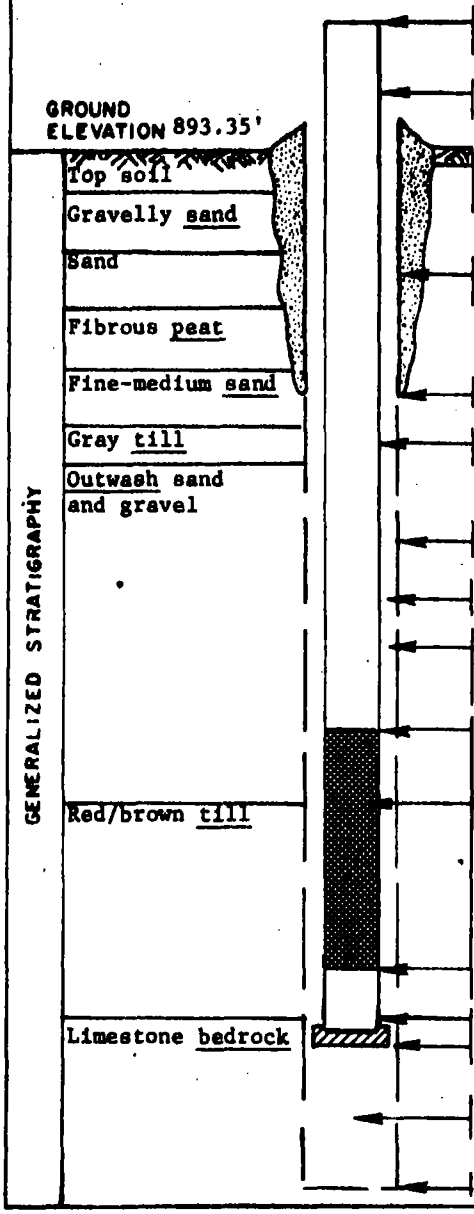
COORDINATES -

DATE COMPLETED 11/10/82

SUPERVISED BY P. Huidobro

WELL NO. PB140

AQUIFER Glacial Drift



Elevation of reference point 895.99'

Height of reference point above ground surface 2.64

Depth of surface seal 1.0'

Type of surface seal: concrete

I.D. of surface casing 4"

Type of surface casing: steel 7' long

Depth of surface casing 4.46'

I.D. of riser pipe 2"

Type of riser pipe: galvanized steel

Diameter of borehole 4"

Type of filler: 1:1 cement bentonite

Elevation / depth of top of seal 831.35'/62.0'

Type of seal: 6/1 cement bentonite

Type of gravel pack No. 20 silica sand

Elev./depth of top of gravel pack 830.35'/63.0'

Elevation / depth of top of screen 827.65'/65.7'

Description of screen No. 10 slot welded galvanized steel

I.D. of screen section 2"

Elevation / depth of bottom of screen 824.65'/68.7'

Elev./depth of bottom of gravel pack 823.35'/70.0'

Elev./depth of bottom of plugged blank section 822.35'/71.0'

Type of filler below plugged section bentonite pellets

Elevation of bottom of borehole 822.35'/71.0'

GCA CORPORATION
Technology Division

FORM 1002

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	B141

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Hwy. 7, West of Louisiana Ave. EXT.	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
11/15/82	11/15/82	BRAUN ENGR	CME 75	4"	-	-	65'

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	13	-	914.00	-	-

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 # 130"	-	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	SAMPLE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	SAMPLE	LAB SAMPLE NO.
									914		
SS 2.5"	2'	1.1'	37		12	9	8	8		1	-
SS	2'	1.3'	41		13	11	8	9		2	2
SS	2'	1.5'	57		14	12	11	20		3	3
SS	2'	1.5'	102		26	23	18	35		4	-
SS	2'	1.8'	82		37	14	10	21		5	-
SS	2'	0.4'	60		12	12	19	17	884'	6	-
									881'		
SS	2'	2'	65		4	11	18	32	879'	7	7
SS	2'	2'	27		3	6	8	10		8	8
									870.5'		
SS	2'	1.8'	41		3	8	14	16		9	9
									866'		

DEPTH, ft: 5, 10, 15, 20, 25, 30, 35, 40, 45

DESCRIPTION AND CLASSIFICATION

0'-1'. Black sand and gravel.

1'-30' is fill material that comprises the embankment for the Hwy 7 overpass. No particular odor or visible contaminants are detected in this interval. Fill is poorly sorted material ranging from fine sand to fine gravel. Sand fraction consists mostly of qtz and rock fragments at LS and mafic rx. Gravel is composed mostly of well rounded pebbles of gabbro and red SS. Between 18' and 30' there are small blotches of yellow-brown oxidized zones.

30'-33'. Black silty clay with Lg% fine sand.

33'-35'. Uniform layer of brownish peat, rich in light-brown fibers. Odorless

35'-43.5'. Organic rich, well compacted dark grey decomposed peat with abundance of fresh H_2O shell fragments. Layer is odorless acid structureless.. Mostly silt with some clay.

43.5'-48'. Grey till made up of about 90% very fine sand and silt with clay and fine gravel. Strong creosote smell.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Drilling on a 2-lane hwy. One lane closed time limitations for drilling. No casing is used. Hollow stem auger is used instead, with RB as appropriate. Sampler ahead of auger.

SS: SPLIT SPOON: ST: SHELBY TUBE D: DENNISON: P: PITCHER: O: OTHER

SITE	HOLE NO.
Hwy. 7 West of Louisiana Ave. Ext.	B141

FORM 1003A

BORING LOG

PROJECT	JOB NO	SHEET NO	HOLE NO
Reilly Tar	1-619-078	2 OF 2	B141

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
								866'					
SS	2'	0	61	22	15	12	12			10	48'-65'. Outwash moderately to poorly sorted sands mixed with some gravel sand portion, consists of qtz, red SS, and mafic rock fragments. Feldspar content is <5%, mostly orthoclose. Gravel grains measure up to about 3 cm. consist of well rounded pebbles of mafic rocks and quartzite.		-
									50				
SS	2'	1.2"	61	16	13	14	18			11			11
									55			Forced to abandon site at 15:30. Boring grouted to the top and cuttings discarded on site.	
SS	2'	0.4"	60	21	13	12	14			12			-
									60				
SS	2'	0	63	27	14	12	10	849'		13			-
									65		Bottom of hole		

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Hwy. 7 West of Louisiana Ave. Ext.

HOLE NO. B141

FORM 10058

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	B142

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Walker Ave. & Louisiana Ave. Ext.	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
11/11	11/11/82	BRAUN ENGR	CME 75	4"	63.7	0	63.7 ft.

CORE RECOVERY (ft, %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	15	-	890.11	-	63.7/ 826.41'

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 #130"	-	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	LAB SAMPLE NO.
									890.11			
									889.61			
SS 2.5"	2'	1'	27	50	3	6	11	10	888.11		1	-
SS	2'	8"	30	33	6	6	9	15			2	-
ST	2.5'	1.9'		76					884.61	5	3	3*
									883.61			
SS	2'	0.7'	29	35	9	8	11	10	880.11		4	-
										10		
SS	2'	1.5'	37	75	11	12	13	12			5	5
										15		
SS	2'	0	24	0	9	9	8	7			6	-
										20		
SS	2'	1'	42	50	20	18	12	12			7	7
										25		
SS	2'	0	34	0	8	13	11	10			8	-
										30		
SS	2'	1'	46	50	33	15	15	16			9	9
										35		
SS	2'	8"	28	33	6	8	13	7			10	-
										40		
SS	2'	1'	26	50	4	6	9	11			11	11
										45		

DESCRIPTION AND CLASSIFICATION

0-0.5'. Top soil, organic, grass, roots

0.5-2'. Brown fill sandy clay, fibrous fine gravel (1 cm). No odor or contaminants present, sand amount increases.

2'-5.5'. Brown peat, fibrous @ 3-4' non-fibrous @ 4'-5.5'.

5.5'-6.5'. Medium to coarse sand.

6.5'-10'. Uniform layer of black organic soil, mostly clay with fine gravel up to 1 cm. No odor moist on top.

10'-48'. Outwash:
13'-20'. Moderately sorted coarse sand with strong cresole smell contamination is not visible. 80% qtz, 5% LS, 15% mafic minerals and rock fragments.

23'-45'. Unstratified outwash with very poorly sorted sand and fine gravel (2-10 mm) sand composition similar to 13'-20' layer, gravel is about 50% quartzite fragments, 30% basalt chips and feldspar phenocrysts with perthitic fabric; mixed with fragments of red sandstone, limestone, and mafic rocks. Fragments are very anugular of all shapes.

Creosote smell is still very evident in this layer through to the 45' marker.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Original site under 2' of H_2O due to heavy rain. Moved location across the street. Drill using hallow skin auger with RB as appropriate AW rod. Auger is 3 1/4" I.D. Sample #6 lost due to character of sediments, which are washed out due to grain size. Character of washings remains the same through about the 45' marker: predominantly fine sands.

SS = SPLIT SPOON; ST = SHELBY TUBE
D = DENNISON; P = PITCHER; O = OTHER

SITE: Walker Ave. and Louisiana Ave. Ext.

HOLE NO. B142

FORM 1003A

●●▲ BORING LOG	PROJECT Reilly Tar	JOB NO 1-619-078	SHEET NO 2 of 2	HOLE NO. B142

Sample type and diameter	Sampler advance	Length core run	Sample recovery	Core recovery	Sample blows "N"	Percent core recovery	Penetration blows 1st 6"	2nd 6"	3rd 6"	4th 6"	Elevation	Depth, ft	Graphic log	Sample	Description and classification	Notes on: water levels, water return, character of drilling, etc	Lab sample no.
SS	2'		2'		253	100	26	71	82	100		50		12	48'-55'. Unstratified red glacial till. Strong creosote odor. No visible contamination. Highly compacted silty clay, <5% fine sand; gravel of mostly basalt and angular rock fragments.		12
SS	2'		1.2'		87	60	7	13	26	48	835.11	55		13	55'-63'. Outwash. Brown sand (quartz, mafic rock fragments, red sandstone and LS. Gravel at bottom, LS and red sandstone. Creosote smell.		13
SS	2'		1.5'		180	75	44	40	50	90		60		14			14
											827.11				Bedrock. Weathered limestone.		
SS	0		-		-	0	300				826.41	65		15	Bottom of hole.	Auger jumps and jerks @ 63'. Truck lifted @ 63.7'.	-

SS = SPLIT SPOON · ST = SHELBY TUBE
D = DENNISON · P = PITCHER · O = OTHER

SITE Walker Ave. and Louisiana Ave. Ext.

HOLE NO. B142

FORM 1005B

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB144

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Filled swamp S of Hy 7; 164' W of W13	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft)	TOTAL DEPTH
11/17	11/19/82	Braun Engr	CME-75	4"	51	8	59'

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	13	897.72'	895.02'	-	≈51'/844.02'

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/60'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	SAMPLE	LAB SAMPLE NO.
									895.02		
SS	2'	0	25		10	11	8	6		1	-
SS	2'	1.2'	3		1	1	1	1		2	2
									882.02		
SS	2'	1'	21		5	5	8	8	880.02	3	3
ST	30"	2.5'								4	4*
SS	2'	1.5'	10		0	3	3	4		5	5
SS	2'	1.5'	19		2	7	5	7	871.02	6	6
									868.52		
SS	2'	1'	50		9	15	18	17		7	7
SS	2'	0	53		20	20	17	16		8	-
SS	2'	0	26		24	12	7	7		9	-
SS	2'	0.5'	99		28	41	30	28		10	-

DEPTH, ft: 5, 10, 15, 20, 25, 30, 35, 40, 45

DESCRIPTION AND CLASSIFICATION

0-13'. Topsoil. Black sandy muck, oxidized zones. LS and SS pebles. Strong smell of rubber. Few isolated chunks of fibrous peat.

13'-15'. Brown fibrous peat. Strong creosote and H_2S smell.

15'-24'. Black peat. Very mature with shell fragments. Slightly fibrous. Strong creosote and H_2S smell.

24'-26.5'. Brown silty clay with black blotches. Strong odor.

26.5'-51'. Outwash. Poorly sorted medium to coarse sand and fine to medium gravel. Isolated chunks of bituminous material. Mineralogy of sand is mostly quartz and rock fragments. Gravel is chiefly limestone, mafic rocks, granitic rocks and agate (red). Strong odor of H_2S and creosote

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC

@ 18' no washings come out during casing driving. Probably due to dissolution of organic materials.

*Sample for physical measurements only

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Filled swamp S of Hy 7; 164 W of W13

HOLE NO. PB144

FORM 1003A

BORING LOG	PROJECT Reilly Tar	JOB NO 1-619-078	SHEET NO. 2 OF 2	HOLE NO. PB144

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"		ELEVATION	DEPTH, FT	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO
SS	2'	0	130	48	43	41	34				11			-
								844.02	50				Samples lost here are probably being washed out or the # of blows is the result of compaction of weathered material by the sampler.	
												51'-59'. Limestone bedrock, weathered.		
SS	2'	0	89	55	36	28	25				12			-
									55					
SS	1'	0	-	177	238			836.02			13	Bottom of hole.		-

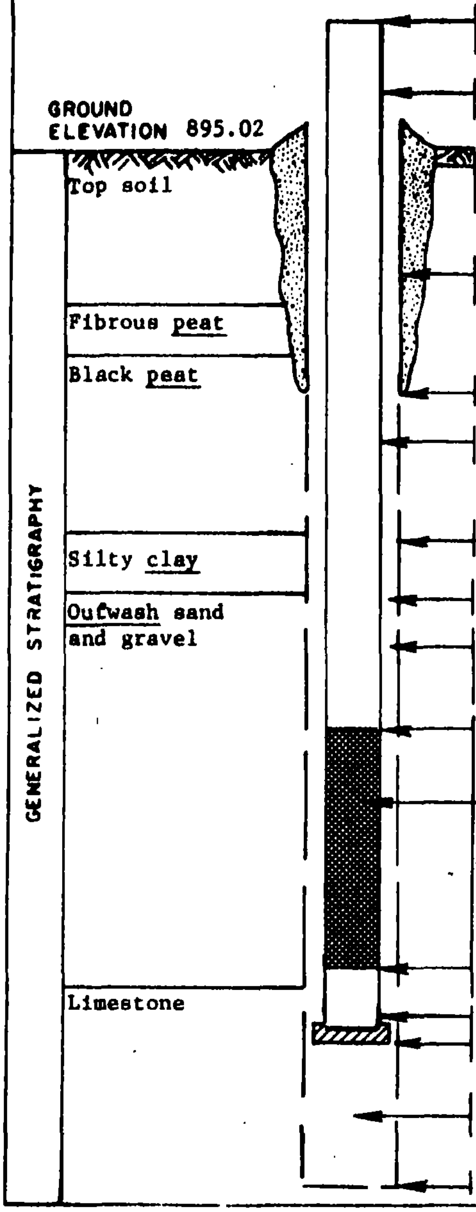
SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE Filled swamp S of Hy 7; 164 W of W13	HOLE NO. PB144

FORM 1003B

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly Tar
SITE Filled swamp;
COORDINATES
DATE COMPLETED 11/19/82
SUPERVISED BY P. Huidobro

WELL NO. PB144
AQUIFER Glacial Drift



Elevation of reference point	897.72
Height of reference point above ground surface	2.70'
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: black steel	
Depth of surface casing	4.3'
I.D. of riser pipe	2"
Type of riser pipe: galvanized, coupled 10.5' section	
Diameter of borehole	4"
Type of filler: 1:1 cement/bentonite	
Elevation / depth of top of seal	853.72/41.3'
Type of seal: 6:1 cement bentonite	
Type of gravel pack No. 20 silica sand	
Elev./depth of top of gravel pack	852.72/42.3'
Elevation / depth of top of screen	850.72/44.3'
Description of screen No. 10 slot galvanized, welded steel	
I.D. of screen section	2"
Elevation / depth of bottom of screen	847.72/47.3'
Elev./depth of bottom of gravel pack	843.02/52'
Elev./depth of bottom of plugged blank section	841.02/54'
Type of filler below plugged section bentonite	
Elevation of bottom of borehole	836.02/59'

GCA CORPORATION
Technology Division

FORM 1002

Attachment 3

PRELIMINARY SUMMARY OF PHYSICAL TESTING RESULTS AT REILLY TAR SITE FOR SAMPLES TAKEN DURING OCTOBER-NOVEMBER 1982 BY GCA/TECHNOLOGY DIVISION

Test	PB 137			PB 138		PB 139	PB 140	PB 142	PB 144
	#1/4'-5' non-fibrous peat	#5/8'-10.5' till	#6/10.5'-13' till	#5/8'-10.5' lac. clay	#13/48'-50' DM outwash	#8/20'-22.5' lac. clay	#5/8'-10.5' lac. clay	#3/4'-6.5' DM outwash	#4/15'-17.5' fibrous peat
K_v (ave.)	7.4×10^{-7}	3.5×10^{-7}	2.1×10^{-7}	7.2×10^{-8}	-	7.6×10^{-8}	-	-	1.2×10^{-7}
K_h	-*	-	-	-	-	-	-	-	-*
Porosity (%)	-*	28	28	39	-	45	-	-	-*
Particle Size	0% gravel 41% sand 55% silt 4% clay	4.7% gravel 49.7% sand 28.1% silt 17.5% clay	2.2% gravel 53% sand 27.1% silt 17.5% clay	1.3% gravel 35.1% sand 44.1% silt 19.5% clay	0% gravel 14.6% sand 75.4% silt 10% clay	0% gravel 15% sand 60% silt 25% clay	-	-	-*
TOC	190,000 mg/kg	2,500 mg/kg	2,100 mg/kg 2,800 mg/kg	3,400 mg/kg	900 mg/kg	6,600 mg/kg	7,600 mg/kg	-	110,000 mg/kg

*Test in progress.

Attachment 4

BORING LOG

GCA

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB136

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Background: 36th & Minnehaha	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
10/18	10/25	Braun Engr	CME-75	4"	87.5	6	93.5'

CORE RECOVERY (ft./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	21	910.53	908.88	8.6'/900.28	87.5/821.38

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈95'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	SAMPLE RECOVERY	SAMPLE BLOWS "N"	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
								908.88					
SS/2.5"	2'	6"	11	2	3	3	5			1	0-4'. Topsoil, organic, roots, and grass.	Mud & cuttings discharged to creek as OK by Mike Hansel; standpipe with 2.65' stickup. Water table ≈8.6'. Operation start @ 11:00. SS sampler is 2.5" ID and the tip is flush inside.	-
SS	2'	12"	13	3	3	4	6	904.88		2			
SS	2'	14"	10	2	2	4	4	902.88	5	3	4'-6'. Brown fibrous peat.		3
								902.38			6'-6.5'. Black nonfibrous peat.		
SS	2'	20"	10	2	1	4	5	900.88		4	6.5'-8'. Med. to coarse sand with organic rich S/C zones.		4
SS	2'	24"	11	4	4	4	3	899.38		5	8'-9.5'. Nonfibrous peat.		5
								898.88	10		9.5'-10'. Outwash sand.		
SS	2'	23.6"	35	9	11	11	13			6	10'-26'. Gray till. Very fine silty clay with scattered pebbles of limestone, sandstone (red) and mafic rocks.		6
									15				
SS	2'	23.2"	38	4	10	12	16			7			-
									20				
SS	2'	18"	33	6	9	12	12			8			-
									25				
								882.88			26'-38'. Coarse outwash. Coarse sand (reddish/brown) fine fine to medium gravel of red sandstone, limestone, and basaltic rocks, and rock fragments.		
SS	2'	0	50	12	16	17	17			9			-
									30				
SS	2'	0.7'	47	10	14	23	10			10			10
									35				
								870.88					
SS	2'	2'	57	15	21	16	20			11	38'-51.5'. Gray till. Similar in texture to above till layer. A few oxidized S/C rich layer (thin) are observed.		-
									40				
SS	2'	4"	94	21	19	32	43			12			-
									45				

SS=SPLIT SPOON; ST=SHELBY TUBE D=DENNISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	Background: 36th & Minnehaha	PB136

FORM 1003A

BOA	BORING LOG	PROJECT: Reilly Tar	JOB NO: 1-619-078	SHEET NO: 2 OF 2	HOLE NO: PB136

Sample Type and Diameter	Sampler Advance / Length Core Run	Sample Recovery / Core Recovery	Sample Blows "N"	Percent Core Recovery	Penetration Blows 1st 6"	2nd 6"	3rd 6"	4th 6"	Elevation	Depth, ft	Graphic Log	Sample	Description and Classification	Notes on: Water Levels, Water Return, Character of Drilling, etc	Lab Sample No.
SS	2'	3"	77		20	26	21	30				13		Reduced sampler tip to specs.	-
									857.38	50					
SS	2'	9.5"	120		35	38	38	44				14	51.5'-56'. Outwash <u>sand</u>. Medium sand; quartz, feldspars and rock fragments, fine gravel of mafic rocks.		-
									852.88	55					
SS	2'	9"	55		16	18	16	21				15	56'-66'. Gray <u>till</u> similar in texture and composition to above till layers.		-
										60					
SS	2'	0	171		21	41	55	75				16			-
									842.88	65					
SS	2'	0	301		44	80	126	95				17	66'-71'. Medium <u>sand</u>, poorly sorted, with fine gravel.		-
									837.88	70					
SS	2'	0.85'	153		36	44	46	63				18	71'-76.5'. Gray <u>till</u> similar in texture and composition as above till layers.		18
									832.38	75					
SS	2'	1.85'	173		35	45	64	64	830.38			19	76.5'-78.5'. <u>Sand</u> matrix with fine gravel.		19
									827.38	80			78.5-81.5'. Gray <u>till</u> similar in texture and composition as above till layers.		
SS	2'	0.8'	225		19	60	86	79				20	81.5-87.5'. Reddish/brown medium <u>sand</u> matrix with pebbly gravel.		20
										85					
SS	1'	1'	180		21	180	-	-	821.38			21	87.5'-93.5'. Weathered limestone <u>bedrock</u>.	Loss of all washing and mud @ 87.5'.	21
										90					
									815.38				Bottom of hole.		

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Background: 36th & Minnehaha

HOLE NO. PB136

FORM 1005B

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT: Reilly TAR 1-619-078

SITE: Background clean location 36th & Minnehaha

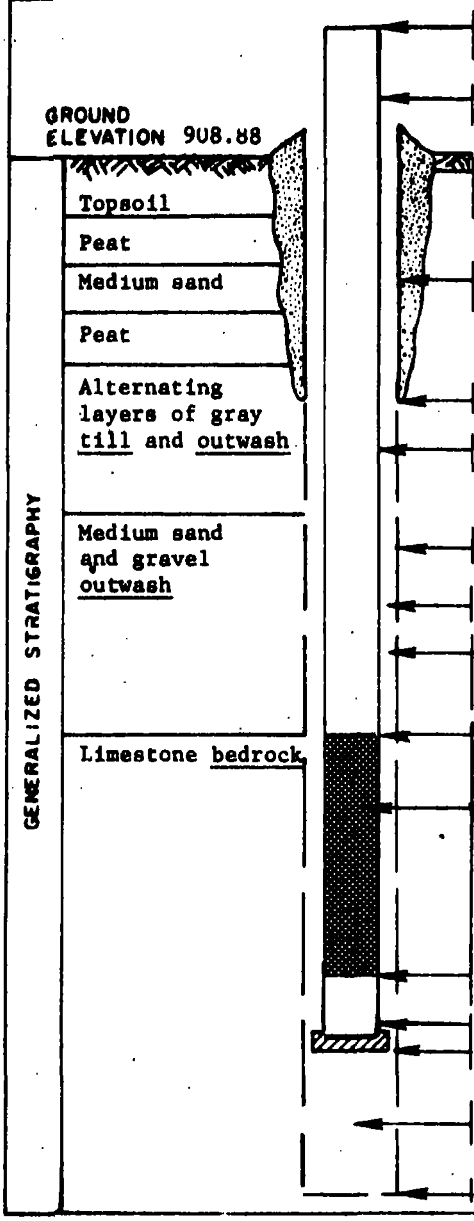
COORDINATES:

DATE COMPLETED: 10/25/82

SUPERVISED BY: P.Huidobro

WELL NO. PB136

AQUIFER: Platteville Limestone



Elevation of reference point	910.53
Height of reference point above ground surface	1.65
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: steel with vented locking cap	
Depth of surface casing	5.35'
I.D. of riser pipe	2"
Type of riser pipe: galvanized 10.5 section	
Diameter of borehole	4"
Type of filler: cement/bentonite 1:1	822.88/86'
Elevation / depth of top of seal	
Type of seal: 6/1 cement/bentonite	
Type of gravel pack No. 20 silica sand	
Elev./depth of top of gravel pack	821.38/87.5'
Elevation / depth of top of screen	819.58/89.3'
Description of screen 3'x2" welded slot No. 10 galvanized steel	
I.D. of screen section	
Elevation / depth of bottom of screen	816.58/92.3'
Elev./depth of bottom of ~~gravel pack~~ bentonite	816.58/92.3'
Elev./depth of bottom of plugged blank section	815.38/93.5'
Type of filler below plugged section bentonite	
Elevation of bottom of borehole	≈ 815.38/93.5'

GCA CORPORATION
Technology Division

FORM 1002

BORING LOG

GCA

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB137

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Background: 36th & Minnehaha	located approximately 30' N of PB136	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
10/26	10/28	Braun Engr	CME-75	4"	85.0	1.5	86.5'

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	8	910.9	909.14	8.7'/900.44'	85/824.14

SAMPLE HAMMER WEIGHT / FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈90'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN / SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION 909.14	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	LAB SAMPLE NO.
SS/2.5"	2'	0.7'	14		2	4	5	5			1	0-3'. Topsoil with grass and roots and pebbles.		-
SS	2'	0.8'	14		4	5	4	5	906.14		2			-
ST	1'	1'								5	3	3'-7.5'. Fibrous peat.	ST = 3" x 30"	3*
ST	2.5'	0									4			4*
ST	2.5'	2.5'							▽	10	5	7.5'-11.5'. Top and bottom of sampler show gray clays.	Water table @≈8'	5*
ST	2.5'	2.5'							897.64		6	11.5'-25'. Gray till. Assumed from log of borehole PB136.	Washings are uniform throughout the rest of the hole. Showing fine gravels and some gray S/C. Very little sand.	6*
									884.14	15, 20, 25				
												25'-37.5'. Coarse outwash. Assumed same stratigraphy as borehole PB136.		
ST	0	0									7			-
									871.64	30, 35				
										40, 45		37.5'-51.5'. Gray till. Assumed same stratigraphy as borehole PB136.	*Sample for physical measurement only	

SS=SPLIT SPOON; ST=SHELBY TUBE
D=DENNISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
Background: 36th & Minnehaha	PB137

FORM 1003A

BORING LOG

PROJECT	JOB NO	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	2 OF 2	PB137

Sample Type and Diameter	Sampler Advance	Length Core Run	Sample Recovery	Core Recovery	Sample Blows "N"	Percent Core Recovery	Penetration Blows 1st 6"	2nd 6"	3rd 6"	4th 6"	Elevation	Depth, ft	Graphic Log	Sample	Description and Classification	Notes on: Water Levels, Water Return, Character of Drilling, etc	Lab Sample No.
											857.64	50					
											853.14	55			51.5'-56'. Outwash sand. Assumed same stratigraphy as borehole PB136.		
											843.14	60, 65			56'-66'. Gray till. Assumed same stratigraphy as borehole PB136.		
											838.14	70			66'-71'. Medium sand. Assumed same stratigraphy as borehole PB136.		
											832.64	75			71'-76.5'. Gray till. Assumed same stratigraphy as borehole PB136.		
											830.64				76.5'-78.5. Sand and gravel. Assumed from borelog PB136.		
												80			78.5'-85'. Gray till. Assumed same stratigraphy as PB136.		
ST	1'	1'									824.14	85		8		Loss of H_2O & mud. Roller bit to 86.5' is difficult and jumpy. No washings are recovered.	8*
											822.64				85'-86.5'. Bedrock. Weathered limestone.		
												90			Bottom of hole		

SS = SPLIT SPOON; ST = SHELBY TUBE
D = DENNISON; P = PITCHER; O = OTHER

SITE Background: 36th & Minnehaha

HOLE NO. PB137

FORM 10038

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT: Reilly TAR

SITE: 36 & Minnehaha

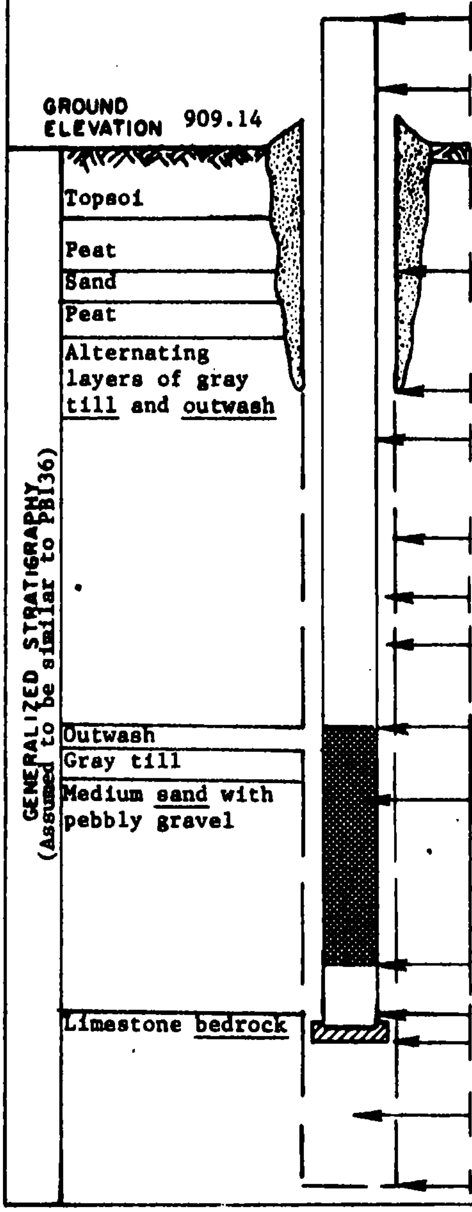
COORDINATES: -

DATE COMPLETED: 10/27/82

SUPERVISED BY: P. Huidobro

WELL NO.: PB137

AQUIFER: Glacial Drift



Elevation of reference point	910.9
Height of reference point above ground surface	1.76
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: steel with vented locking cap	
Depth of surface casing	5.24'
I.D. of riser pipe	2"
Type of riser pipe: galvanized steel	
Diameter of borehole	4"
Type of filler: 1/1 cement/bentonite	
Elevation / depth of top of seal	834.54/74.6'
Type of seal: 1/1 cement/bentonite	
Type of gravel pack silica sand No. 20	
Elev./depth of top of gravel pack	833.54'/75.6'
Elevation / depth of top of screen	826.84'/82.3'
Description of screen No. 10 slot welded galvanized steel	
I.D. of screen section	
Elevation / depth of bottom of screen	822.64'/86.5'
Elev./depth of bottom of gravel pack	822.64'/86.5'
Elev./depth of bottom of plugged blank section	822.64'/86.5'
Type of filler below plugged section	
Elevation of bottom of borehole	822.64'/86.5'

GCA CORPORATION
Technology Division

FORM 1002

GCA BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB138

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
34th & Xylon-Wyoming	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft)	TOTAL DEPTH
10/29	11/2/82	Braun Engr	CME-75	4"	77.8	0.7	78.5'

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
140#/30"	-	19	909.77'	907.46'	-	77.8'/829.66'

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈80'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN	SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION 907.46	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	LAB SAMPLE NO.
SS/2.5"	2'		1.2'		26		4	7	8	11			1	0-4'. Topsoil. Sand and pebbles, roots, grass, and gray clay.	Drilling, uninterrupted using method of sampling ahead of the casing; RB 3' and driving casing 5' supply of mud is continuous now, due to use of a Longyear mud mixer. Operation goes faster and without problem	-
SS	2'		0.8'		30		12	9	9	12	903.46		2			-
SS	2'		0.6'		21		6	7	8	6	900.96	5	3	4'-6.5'. Brown sand, mostly quartz, chunks of tar; oxidized S/C zones.		3
SS	2'		1.5'		20		4	5	8	7	900.46		4	6.5'-7.0'. Fibrous peat.		-
ST/3.0"	2.5'		1.8'		-		-	-	-	-	896.96	10	5	7.0'-10.5'. Black/brown nonfibrous peat.		5*
														10.5'-14.5'. Poorly sorted sand with fine gravel. Mostly quartz and feldspar.		
SS	2'		1'		44		16	12	14	18	892.96	15	6	14.5'-30'. Gray till. Dense, fine silt and clay. Pebbles of limestone, angular, and rounded mafic rocks; red sandstone and agate (red). Yellow/brown oxidation zones at the top.		-
SS	2'		1.8'		23		4	6	7	10		20	7			7
SS	2'		1.7'		35		7	8	11	16		25	8			-
SS	2'		1.8'		49		23	11	17	21	877.46	30	9			-
														30'-34'. Coarse gravel of weathered limestone, olivine basalt, red sandstone and granitic rocks.		
SS	2'		1'		290		80	66	90	134	873.46	35	10	34'-64'. Outwash sand. Brown, moderate to well sorted. Mostly quartz, agate, and mafic minerals, some orthoclase. Grain size increases with depth. Thin, very dense silt and clay layers observed at 53' and 59.5'.		10
SS	2'		2'		147		50	49	45	53		40	11			-
SS	2'		1.5'		178		55	59	56	63		45	12		*Sample for physical measurements only.	12

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE	HOLE NO.
	34th & Xylon/Wyoming	PB138

FORM 1003A

BORING LOG	PROJECT: Reilly Tar	JOB NO: 1-619-078	SHEET NO.: 2 OF 2	HOLE NO.: PB138

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
SS	30"	24"	-	-	-	-	-		50	13			-
SS	2'	16"	315	84	127	100	88		55	14			-
SS	2'	1.5'	417	83	104	100	213		60	15			-
SS	2'	1.5'	167	55	47	54	66	843.46	65	16	64'-67.5'. Medium to coarse outwash sand and fine gravel with thin layers of silt and clay.		16
								839.96					
SS	2'	1.5'	86	28	29	30	27		70	17	67.5'-75'. Gray clay, dense, with very fine lenses of fine sand. Large rafted pebbles of basaltic composition.		-
SS	2'	14"	64	23	23	19	22	832.46	75	18			18
								829.66			75'-77.8'. Coarse sand with chips of weathered limestone.		
SS	3"	0	-	300	-	-	-	828.96	80	19	77.8'-78.5'. Bedrock, weathered limestone. Bottom of hole. 78.5'.	No loss of H_2O at bedrock contact. Washings from 8.0' come out with fine sand and large LS chips.	-

SS: SPLIT SPOON; ST: SHELBY TUBE; D: DENNISON; P: PITCHER; O: OTHER

SITE: 34th & Xylon/Wyoming

HOLE NO. PB138

FORM 1003B

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly TAR

SITE 34th & Xylon/Wyoming

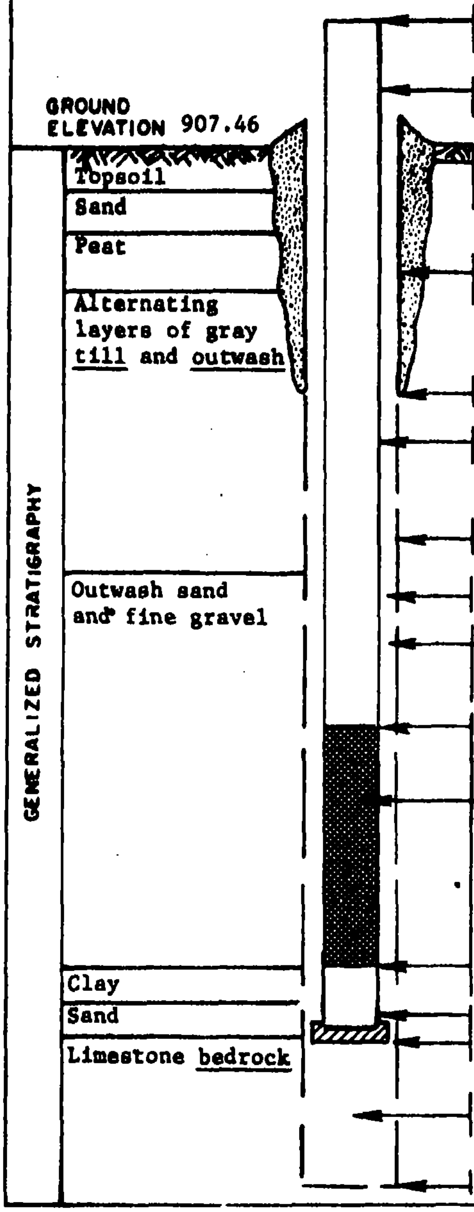
COORDINATES -

DATE COMPLETED 11/2/82

SUPERVISED BY P. Huidobro

WELL NO. PB138

AQUIFER Glacial Drift



- Elevation of reference point: 909.77
- Height of reference point above ground surface: 1.81
- Depth of surface seal: 1'
- Type of surface seal: concrete
- I.D. of surface casing: 4"
- Type of surface casing: steel
- Depth of surface casing: 5.19'
- I.D. of riser pipe: 2"
- Type of riser pipe: galvanized steel, coupled
- Diameter of borehole: 4"
- Type of filler: cement/bentonite 1:1
- Elevation / depth of top of seal: 849.96/57.5'
- Type of seal: 6:1 cement/bentonite
- Type of gravel pack: silica sand #20
- Elev./depth of top of gravel pack: 848.16/59.3'
- Elevation / depth of top of screen: 843.96/63.5'
- Description of screen: No. 10 slot welded galvanized steel
- I.D. of screen section: 2"
- Elevation / depth of bottom of screen: 840.96/66.5'
- Elev./depth of bottom of gravel pack: 835.46/72'
- Elev./depth of bottom of plugged blank section: 828.96/78.5'
- Type of filler below plugged section: bentonite
- Elevation of bottom of borehole: 828.96/78.5'

FORM 1002

GCA CORPORATION
Technology Division

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB139

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
31st & Quebec	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
11/3	11/4/82	Braun Engr.	CME75	4"	63.5	4.0	67.5'

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	17	896.45	893.67	-	64'/829.67

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/≈70'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN / SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	LAB SAMPLE NO.
										893.67				
SS 2.5"	2'	14"		29		3	7	11	11			1	0-6'. Topsoil. Organic rich, roots and oxidized zones. Coarse sand and gravel. Bioturbated.	-
SS	2'	1.2'		49		8	15	15	19			2		-
SS	2'	2'		60		12	16	20	24	887.65	5	3		-
SS	2'	1.5'		11		3	3	3	5			4	6'-18'. Thin layer (3") of fibrous peat followed by black, nonfibrous peat, strong decomposition odor.	4
SS	2'	1.5'		7		0	2	2	3			5		-
											10			
SS	2'	0		13		5	4	4	5		15	6		-
										875.67				
SS	2'	14"		7		1	2	2	3		20	7	18'-21.5'. Lacustrine clayey silt with thin lenses of fine sand.	-
ST/30"	30"	30"								872.17		8	21.5'-22'. Medium sand.	8
										871.67				
										869.97			22'-23.7'. Silty clays.	
SS	2'	14"		47		13	15	20	12	868.67	25	9	23.7'-25'. Outwash sand with <1% gravel.	9
SS	2'	1.5'		52		13	11	17	24		30	10	25'-34.5'. Gray till. Fine sand in a S/C matrix with gravel of granitic and mafic rocks, and limestone. Red/brown oxidized zones interlayered.	10
SS	2'	1'		66		22	21	20	25	859.17	35	11		-
SS	2'	0		48		23	18	15	15		40	12	34.5'-64'. Outwash sand and gravel. Sand fraction is brown, fine to coarse consisting mostly of quartz and rock fragments. Fine to coarse gravel of both gravimitic and mafic rocks mixed with limestone and red sandstone. A one-inch layer of red till is observed at the bottom of the outwash layer in contact with the limestone bedrock.	-
SS	2'	0		72		28	27	20	25		45	13		-

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Continuous sampling for top 10', after which samples are taken ahead of the H casing, after RB and introduction of casing. Safety considerations are applied as per contract requirements because site is suspected to be contaminated. No contamination by oil or creosote is observed in the RB washings and cuttings.

Character of washings at the interval where no samples are recovered are consistent with those above and below those

SS = SPLIT SPOON: ST = SHELBY TUBE
D = DENNISON: P = PITCHER: O = OTHER

SITE 31st & Quebec

HOLE NO. PB139

FORM 1003A

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	2 OF 2	PB139

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
SS	2'	1'	73	19	26	22	25		50	14		intervals. Core catcher replaced after sample # 13. Samples 15 & 16 are impossible to extrude from liners, possibly due to highly cohesive fine sands. @ 64', RB's jumpy and hydraulic pressure 800 lb. Washing contains checks of weathered limestone.	-
SS	2'	4"	117	33	38	38	41		55	15			-
SS	2'	1'	153	40	46	52	55		60	16			16
SS	0.5'	0		200	-	-	-	829.67	65	17	64'-67.5'. Bedrock. Limestone.		-
								826.17			Bottom of hole.		
									70				

SS: SPLIT SPOON; ST: SHELBY TUBE
D: DENNISON; P: PITCHER; O: OTHER

SITE 31st & Quebec

HOLE NO. PB139

FORM 1003B

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly Tar
SITE 31st & Quebec
COORDINATES -
DATE COMPLETED 11/5/82
SUPERVISED BY P. Huidobro

WELL NO. PB139
AQUIFER Glacial Drift

GROUND ELEVATION 893.67

GENERALIZED STRATIGRAPHY

- Topsoil
- Peat
- Lacustrine clay
- Alternating layers of gray till and outwash
- Outwash sand and gravel
- Limestone bedrock

Elevation of reference point		896.45
Height of reference point above ground surface		2.78'
Depth of surface seal		1'
Type of surface seal:	concrete	
I.D. of surface casing		4"
Type of surface casing:	steel 7'x4"	
Depth of surface casing		4.22'
I.D. of riser pipe		2"
Type of riser pipe:	coupled glavanized steel	
Diameter of borehole		4"
Type of filler:	1:1 cement/bentonite	
Elevation / depth of top of seal		838.67/55'
Type of seal:	6:1 cement/bentonite	
Type of gravel pack	silica sand	
Elev./depth of top of gravel pack		837.17/56.5'
Elevation / depth of top of screen		834.67/59.0'
Description of screen	No. 10 slot welded steel	
I.D. of screen section		2"
Elevation / depth of bottom of screen		831.67/62.0'
Elev./depth of bottom of gravel pack		827.67/66.0'
Elev./depth of bottom of plugged blank section		826.17/67.5'
Type of filler below plugged section	bentonite	
Elevation of bottom of borehole		826.17/67.5'

GCA CORPORATION
Technology Division

FORM 1002

GCA	BORING LOG	PROJECT: Reilly Tar	JOB NO. 1-619-078	SHEET NO. 1 OF 2	HOLE NO. PB140

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Louisiana Ave. Near W23	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft)	TOTAL DEPTH
11/8/82	11/10/82	BRAUN ENGR	CME 75	4"	70	1	71 ft.

CORE RECOVERY (ft./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	18	895.99'	893.35'	-	70/823.60

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 #130	2"/≈ 73'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION 893.35'	DEPTH, ft	SAMPLE	LAB SAMPLE NO.
SS/ 2.5"	1.6'	1.5'	272		2	10	31	231	891.60'		1	-
SS	2'	1.5'	126		105	53	38	35			2	2
SS	2'	1'	31		12	14	9	8	888.35'	5	3	3
SS	2'	1.8'	21		6	5	7	9	885.35'		4	4
ST	30"	18"								10	5	*5
									881.85 / 880.35			
SS	2'	16"	34		14	11	11	12		15	6	6
									877.35			
SS	2'	1''	59		20	21	17	21		20	7	-
SS	2'	0	71		20	19	22	29		25	8	-
SS	2'	6"	45		16	15	16	14		30	9	-
SS	2'	o	55		19	20	18	17		35	10	-
SS	2'	0	100		18	22	32	46		40	11	-
SS	2'	0	111		49	32	34	45			12	-
SS	2'	4"	50		9	14	20	16		45	13	-

DESCRIPTION AND CLASSIFICATION

0-1.75'. Top Soil, brown sandy clay with roots and grass.

1.75'-5'. Well compacted black bituminous material. Gravelly sand all coated with black material. Tar smell. Material is very brittle

5'-8'. Coarse moderately sorted brown sand. Mostly qtz and rock frags red in color 1" layer of black sand (coated)

8'-11.5'. Very uniform layer of fibrous peat. Gray-black silty clay with gravel (4 cm). Strong farry smell.

11.5'-13'. Gray medium-fine sand, most qtz with some gravel, weathered LS and x-line rocks.

13'-16'. Very small silty clay gray on top and brown at bottom interlayered with coarse gravel. Till.

16'-65'. Outwash. Mod. sorted sand and fine gravel. It is not possible to determine its color because the grains appear to be saturated with very smelly "oily" fluid that covers all particles with an irridescent sheen. Mineralogy and petrology are tentative at best, mostly qtz and rock fragments. Gravel components are LS, red SS and xtaline rocks of basaltic nature as well as perthitic igneous rocks. Subporphyritic mafic rocks are also present. Phaneritic rocks of granitic composition with subhedral fabric. Gravel component decreases with depth and the sediment becomes better sorted in the medium to coarse sand range, which is about 90% qtz with little feldspars and rock fragments. Silt and clay content of this outwash is less than 10%.
48'-50' into the outwash consists of poorly sorted very fine to coarse sand; with <5% gravel and traces of silt and clay. Sand is reddish brown in color, and consists mostly of qtz with a larger component of red and black rock fragments and some red SS chips. Rock fragments are very angular and in general with a high sphericity value.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Using existing pit to dispose of cuttings and mud. Samples recovered from tarry layer are impossible to extrude from liners; they have to be scraped off. Washing from smelly zones come out with an irridescent oily film on top. HNU reading is 75 ppm.
Casing does not advance beyond 27; goes through. When pulled out drill pipe is chewed up, bit brings up a large chunk of jasper.
Cuttings from RB from 30'-55' consist of sand and broken gravel. Sand is fine and gravel is about 1 cm.
It is possible that this material is not held properly by the core catcher, or interfering with the ball valve on top, thus the samples are flushed out.
Left the site @ 16:30 after hitting bedrock heavy snow and hail/sleet.

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER	SITE: Louisiana Ave. Near W23	HOLE NO. PB140

FORM 10034

●●A	BORING LOG	PROJECT Reilly Tar	JOB NO. 1-619-078	SHEET NO. 2 OF 2	HOLE NO. PB140

Sample Type and Diameter	Sampler Advance	Length Core Run	Sample Recovery	Core Recovery	Sample Blows "N"	Percent Core Recovery	Penetration Blows 1st 6"	2nd 6"	3rd 6"	4th 6"	Elevation	Depth, ft	Sample	Description and Classification	Notes on: Water Levels, Water Return, Character of Drilling, Etc	Lab Sample No.
SS	2'		0.5		65		18	29	18	18		50	14	58'-60'. Outwash zone with mineralogy and petrology similar to overlying zone. Well sorted medium sand 90% qtz 10% feldspars and fragments or mafic rx and red SS. Traces of S/C. No gravel.		14
SS	2'		0		122		34	43	41	38		55	15	63'-65'. Outwash is poorly sorted very fine to coarse brown sand with about 5% gravel.		-
SS	2'		10"		54		21	22	17	15		60	16			16
SS	2'		10"		122		24	31	59	32		65	17			-
SS	1.5'		0.5'		192		50	40	152		823.35	70	18	65'-70'. Red/brown till in contact with bedrock. This unit is composed of 70% very fine sand, 25% silt and clay and 5% medium gravel. Fine portion is mostly qtz while pebbles are of mafic rock, and LS, angular to rounded. Unstratified.		-
											822.35			Bedrock - Bottom of hole.		
												75			*Sample for physical measurements only	

SS=SPLIT SPOON; ST=SHELBY TUBE
D=DENNISON; P=PITCHER; O=OTHER

SITE Louisiana Ave. Near W23

HOLE NO. PB 140

FORM 10038

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly Tar

SITE Louisiana Ave. next to W23

COORDINATES -

DATE COMPLETED 11/10/82

SUPERVISED BY P. Huidobro

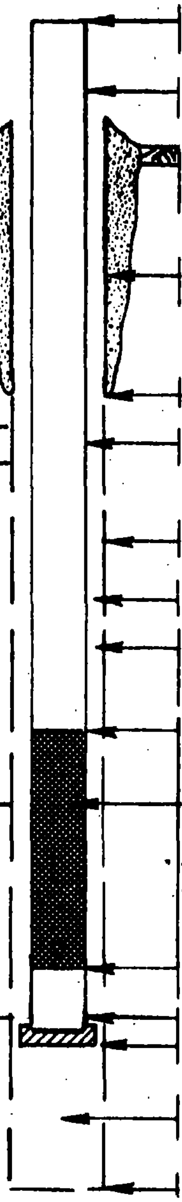
WELL NO. PB140

AQUIFER Glacial Drift

GROUND ELEVATION 893.35'

GENERALIZED STRATIGRAPHY

- Top soil
- Gravelly sand
- Sand
- Fibrous peat
- Fine-medium sand
- Gray till
- Outwash sand and gravel
- Red/brown till
- Limestone bedrock



Elevation of reference point	895.99'
Height of reference point above ground surface	2.64
Depth of surface seal	1.0'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: steel 7' long	
Depth of surface casing	4.46'
I.D. of riser pipe	2"
Type of riser pipe: galvanized steel	
Diameter of borehole	4"
Type of filler: 1:1 cement bentonite	
Elevation / depth of top of seal	831.35'/62.0'
Type of seal: 6/1 cement bentonite	
Type of gravel pack No. 20 silica sand	
Elev./depth of top of gravel pack	830.35'/63.0'
Elevation / depth of top of screen	827.65'/65.7'
Description of screen No. 10 slot welded galvanized steel	
I.D. of screen section	2"
Elevation / depth of bottom of screen	824.65'/68.7'
Elev./depth of bottom of gravel pack	823.35'/70.0'
Elev./depth of bottom of plugged blank section	822.35'/71.0'
Type of filler below plugged section bentonite pellets	
Elevation of bottom of borehole	822.35'/71.0'

GCA CORPORATION
Technology Division

FORM 1002

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 of 2	B141

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Hwy. 7, West of Louisiana Ave. Ext.	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
11/15/82	11/15/82	BRAUN ENGR	CME 75	4"	-	-	65'

CORE RECOVERY (ft./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	13	-	914.00	-	-

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 @ 30"	-	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN	SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.	LAB SAMPLE NO.
											914	0		0'-1'. Black sand and gravel.	Drilling on a 2-lane hwy. One lane closed time limitations for drilling. No casing is used. Hollow stem auger is used instead, with RB as appropriate. Sampler ahead of auger.	
SS 2.5"	2'	1.1'			37		12	9	8	8		5	1	1'-30' is fill material that comprises the embankment for the Hwy 7 overpass. No particular odor or visible contaminants are detected in this interval. Fill is poorly sorted material ranging from fine sand to fine gravel. Sand fraction consists mostly of qtz and rock fragments at LS and mafic rx. Gravel is composed mostly of well rounded pebbles of gabbro and red SS. Between 18' and 30' there are small blotches of yellow-brown oxidized zones.		-
SS	2'	1.3'			41		13	11	8	9		10	2			2
SS	2'	1.5'			57		14	12	11	20		15	3			3
SS	2'	1.5'			102		26	23	18	35		20	4			-
SS	2'	1.8'			82		37	14	10	21		25	5			-
SS	2'	0.4'			60		12	12	19	17	884'	30	6			-
											881'			30'-33'. Black silty clay with Lg% fine sand.		
SS	2'	2'			65		4	11	18	32	879'	35	7	33'-35'. Uniform layer of brownish peat, rich in light-brown fibers. Odorless		7
														35'-43.5'. Organic rich, well compacted dark grey decomposed peat with abundance of fresh H_2O shell fragments. Layer is odorless and structureless.. Mostly silt with some clay.		
SS	2'	2'			27		3	6	8	10		40	8			8
SS	2'	1.8'			41		3	8	14	16	870.5'	45	9	43.5'-48'. Grey till made up of about 90% very fine sand and silt with clay and fine gravel. Strong creosote smell.		9
											866'					

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Hwy. 7 West of Louisiana Ave. Ext. — HOLE NO. B141

FORM 1003A

BORING LOG

PROJECT	JOB NO	SHEET NO	HOLE NO
Reilly Tar	1-619-078	2 OF 2	B141

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
								866'					
SS	2'	0	61	22	15	12	12		50	10	48'-65'. Outwash moderately to poorly sorted sands mixed with some gravel sand portion, consists of qtz, red SS, and mafic rock fragments. Feldspar content is <5%, mostly orthoclose. Gravel grains measure up to about 3 cm. consist of well rounded pebbles of mafic rocks and quartzite.		-
SS	2'	1.2'	61	16	13	14	18		55	11		Forced to abandon site at 15:30. Boring grouted to the top and cuttings discarded on site.	11
SS	2'	0.4'	60	21	13	12	14		60	12			-
SS	2'	0	63	27	14	12	10	849'	65	13	Bottom of hole		-

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Hwy. 7 West of Louisiana Ave. Ext.

HOLE NO. B141

FORM 1005B

BORING LOG

GCA

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	B142

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Walker Ave. & Louisiana Ave. Ext.	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft.)	TOTAL DEPTH
11/11	11/11/82	BRAUN ENGR	CME 75	4"	63.7	0	63.7 ft.

CORE RECOVERY (ft. %)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	15	-	890.11	-	63.7/ 826.41'

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140 #130"	-	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	LAB SAMPLE NO.
									890.11			
									889.61			
SS 2.5"	2'	1'	27	50	3	6	11	10	888.11		1	-
SS	2'	8"	30	33	6	6	9	15			2	-
ST	2.5'	1.9'		76					884.61	5	3	3*
									883.61			
SS	2'	0.7'	29	35	9	8	11	10	880.11	10	4	-
SS	2'	1.5'	37	75	11	12	13	12		15	5	5
SS	2'	0	24	0	9	9	8	7		20	6	-
SS	2'	1'	42	50	20	18	12	12		25	7	7
SS	2'	0	34	0	8	13	11	10		30	8	-
SS	2'	1'	46	50	33	15	15	16		35	9	9
SS	2'	8"	28	33	6	8	13	7		40	10	-
SS	2'	1'	26	50	4	6	9	11		45	11	11

DESCRIPTION AND CLASSIFICATION

0-0.5'. Top soil, organic, grass, roots

0.5-2'. Brown fill sandy clay, fibrous fine gravel (1 cm). No odor or contaminants present, sand amount increases.

2'-5.5'. Brown peat, fibrous @ 3-4' non-fibrous @ 4'-5.5'.

5.5'-6.5'. Medium to coarse sand.

6.5'-10'. Uniform layer of black organic soil, mostly clay with fine gravel up to 1 cm. No odor moist on top.

10'-48'. Outwash:
13'-20'. Moderately sorted coarse sand with strong cresole smell contamination is not visible. 80% qtz, 5% LS, 15% mafic minerals and rock fragments.

23'-45'. Unstratified outwash with very poorly sorted sand and fine gravel (2-10 mm) sand composition similar to 13'-20' layer, gravel is about 50% quartzite fragments, 30% basalt chips and feldspar phenocrysts with perthitic fabric; mixed with fragments of red sandstone, limestone, and mafic rocks. Fragments are very anugular of all shapes.

Creosote smell is still very evident in this layer through to the 45' marker.

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.

Original site under 2' of H_2O due to heavy rain. Moved location across the street. Drill using hallow skin auger with RB as appropriate AW rod. Auger is 3 1/4" I.D. Sample #6 lost due to character of sediments, which are washed out due to grain size. Character of washings remains the same through about the 45' marker: predominantly fine sands.

SS = SPLIT SPOON: ST = SHELBY TUBE
D = DENNISON: P = PITCHER: O = OTHER

SITE	HOLE NO.
Walker Ave. and Louisiana Ave. Ext.	B142

FORM 1003A

BORING LOG

PROJECT	JOB NO	SHEET NO	HOLE NO
Reilly Tar	1-619-078	2 of 2	B142

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN / SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO.
SS	2'	2'	253	100	26	71	82	100		50	12	48'-55'. Unstratified red glacial till. Strong creosote odor. No visible contamination. Highly compacted silty clay, <5% fine sand; gravel of mostly basalt and angular rock fragments.		12
SS	2'	1.2'	87	60	7	13	26	48	835.11	55	13	55'-63'. Outwash. Brown sand (quartz, mafic rock fragments, red sandstone and LS. Gravel at bottom, LS and red sandstone. Creosote smell.		13
SS	2'	1.5'	180	75	44	40	50	90		60	14			14
									827.11			Bedrock. Weathered limestone.		
SS	0	-	-	0	300				826.41	65	15	Bottom of hole.	Auger jumps and jerks @ 63'. Truck lifted @ 63.7'.	-

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Walker Ave. and Louisiana Ave. Ext.

HOLE NO. B142

FORM 10058

BORING LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
Reilly Tar	1-619-078	1 OF 2	PB144

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
Filled swamp S of Hy 7; 164' W of W13	-	90°	-

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (ft.)	ROCK (ft)	TOTAL DEPTH
11/17	11/19/82	Braun Engr	CME-75	4"	51	8	59'

CORE RECOVERY (ft.%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
-	-	13	897.72'	895.02'	-	≈51'/844.02'

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
140#/30"	2"/60'	P. Huidobro

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE	LENGTH CORE RUN	SAMPLE RECOVERY	CORE RECOVERY	SAMPLE BLOWS "N"	PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"	4th 6"	ELEVATION (895.02)	SAMPLE	LAB SAMPLE NO.
SS	2'		0		25		10	11	8	6		1	-
SS	2'		1.2'		3		1	1	1	1		2	2
											882.02		
SS	2'		1'		21		5	5	8	8	880.02	3	3
ST	30"		2.5'									4	4*
SS	2'		1.5'		10		0	3	3	4		5	5
SS	2'		1.5'		19		2	7	5	7	871.02	6	6
											868.52		
SS	2'		1'		50		9	15	18	17		7	7
SS	2'		0		53		20	20	17	16		8	-
SS	2'		0		26		24	12	7	7		9	-
SS	2'		0.5'		99		28	41	30	28		10	-

DEPTH, ft: 5, 10, 15, 20, 25, 30, 35, 40, 45

DESCRIPTION AND CLASSIFICATION

0-13'. Topsoil. Black sandy muck, oxidized zones. LS and SS pebles. Strong smell of rubber. Few isolated chunks of fibrous peat.

13'-15'. Brown fibrous peat. Strong creosote and H_2S smell.

15'-24'. Black peat. Very mature with shell fragments. Slightly fibrous. Strong creosote and H_2S smell.

24'-26.5'. Brown silty clay with black blotches. Strong odor.

26.5'-51'. Outwash. Poorly sorted medium to coarse sand and fine to medium gravel. Isolated chunks of bituminous material. Mineralogy of sand is mostly quartz and rock fragments. Gravel is chiefly limestone, mafic rocks, granitic rocks and agate (red). Strong odor of H_2S and creosote

NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC

@ 18' no washings come out during casing driving. Probably due to dissolution of organic materials.

*Sample for physical measurements only

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENNISON; P=PITCHER; O=OTHER

SITE: Filled swamp S of Hy 7; 164 W of W13

HOLE NO. PB144

FORM 1003A

BORING LOG

PROJECT: Reilly Tar | JOB NO: 1-619-078 | SHEET NO. 2 OF 2 | HOLE NO. PB144

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE / LENGTH CORE RUN	SAMPLE RECOVERY / CORE RECOVERY	SAMPLE BLOWS "N" / PERCENT CORE RECOVERY	PENETRATION BLOWS 1st 6"	2nd 6"	3rd 6"		ELEVATION	DEPTH, ft	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC	LAB SAMPLE NO
SS	2'	0	130	48	43	41	34			11			-
								844.02	50			Samples lost here are probably being washed out or the # of blows is the result of compaction of weathered material by the sampler.	
											51'-59'. Limestone bedrock, weathered.		
SS	2'	0	89	55	36	28	25			12			-
									55				
SS	1'	0	-	177	238			836.02		13	Bottom of hole.		-

SS = SPLIT SPOON; ST = SHELBY TUBE; D = DENNISON; P = PITCHER; O = OTHER

SITE: Filled swamp S of Hy 7; 164 W of W13

HOLE NO. PB144

FORM 10038

OBSERVATION WELL CONSTRUCTION SUMMARY

PROJECT Reilly Tar

SITE Filled swamp;

COORDINATES -

DATE COMPLETED 11/19/82

SUPERVISED BY P. Huidobro

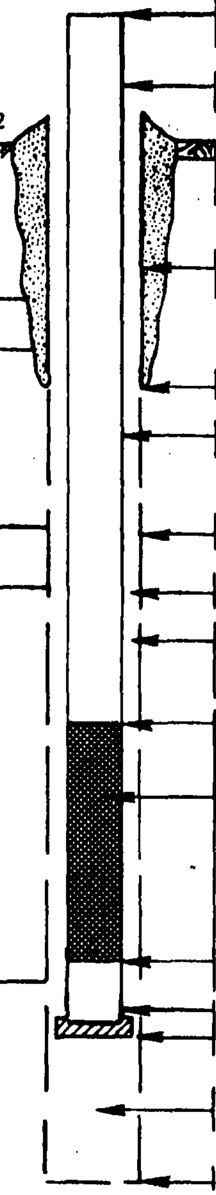
WELL NO. PB144

AQUIFER Glacial Drift

GROUND ELEVATION 895.02

GENERALIZED STRATIGRAPHY

- Top soil
- Fibrous peat
- Black peat
- Silty clay
- Outwash sand and gravel
- Limestone



Elevation of reference point	897.72
Height of reference point above ground surface	2.70'
Depth of surface seal	1'
Type of surface seal: concrete	
I.D. of surface casing	4"
Type of surface casing: black steel	
Depth of surface casing	4.3'
I.D. of riser pipe	2"
Type of riser pipe: galvanized, coupled 10.5' section	
Diameter of borehole	4"
Type of filler: 1:1 cement/bentonite	
Elevation / depth of top of seal	853.72/41.3'
Type of seal: 6:1 cement bentonite	
Type of gravel pack No. 20 silica sand	
Elev./depth of top of gravel pack	852.72/42.3'
Elevation / depth of top of screen	850.72/44.3'
Description of screen No. 10 slot galvanized, welded steel	
I.D. of screen section	2"
Elevation / depth of bottom of screen	847.72/47.3'
Elev./depth of bottom of gravel pack	843.02/52'
Elev./depth of bottom of plugged blank section	841.02/54'
Type of filler below plugged section bentonite	
Elevation of bottom of borehole	836.02/59'

FORM 1002

GCA CORPORATION
Technology Division

11/82
N.

ELEVATIONS OF MONITORING WELLS AND BORINGS INSTALLED BY
GCA Corp./Technology Division, Oct-Nov. 1982.
(Drilling Subcontractor: Braun Engineering Testing, Inc.)

Boring and/or Well #	Surface Elev.	Measuring Point Elev. (Well)	Stick Up	Benchmark Used
PB136	908.88	910.53	1.65	(1)*
PB137	909.14	910.90	1.76	(1)*
PB138	907.46	909.27	1.81	(2)*
PB139	893.67	896.45	2.78	(3)*
PB140	893.35	895.99	2.64	(4)**
B141	914.00	N/A***	N/A	(5)*
B142	890.11	N/A***	N/A	(5)*
PB144	895.02	897.72	2.70	(6)**

* St. Louis Park Benchmarks used: conversion factor = 710.30:

* (1) Top of fire hydrant in SE corner of 36th Street and Burlington Northern RR spur; St. Louis Park Datum = 206.39.

* (2) Top of fire hydrant in NE corner of Xylon Ave. and 34th St.; St. Louis Park Datum = 204.20.

* (3) Top of fire hydrant in SW corner of Quebec Ave. and 34th St.; St. Louis Park Datum = 219.66.

** (4) Measuring Point on Well #W-27 = 910.49.

* (5) Top of fire hydrant in SE corner of Louisiana Ave. and Walker St.; St. Louis Park Datum = 185.35.

* (6) Measuring Point on Well #W-137 = 893.05

Survey conducted by David D. Vieau and Gregory L. Grabow of Braun Engineering Testing, Inc. on 3 December 1982 and 22 March 1983 (to remeasure wells PB140 and PB144 at request of Marc Hult, USGS).

Instruments used: Path Instruments Micro Level L-11, No. 6170011; adjustable tri-pod; adjustable rod marked off in 0.01-foot increments.

** Benchmark Locations and Elevations provided by M. Greg Juston, USGS, 22 March 1983.

*** Boring only - no well installed.

10/29/82
N.

MONSANTO RESEARCH CORPORATION *Inter-Office Correspondence*

From LOCATION : B. M. Hughes, Dayton Laboratory

DATE : 29 October 1982

SUBJECT : Reilly Tar and Chemical Corp. Project

REFERENCE :

c[redacted]
Bill Roder (RTCC)
Files (MRC-Hughes)

RECEIVED

NOV 01 1982

ERT

TO : Gary Wilson
ERT
696 Virginia Road
Concord, Mass 01742

Enclosed are PNA screening chromatograms for RTCC extraction numbers 133-141 and volatile wide-scan screening chromatograms for the CH_2M Hill samples. Also enclosed are copies of MRC analytical request sheets associated with the Well 23 tar analysis and a summary table of all water samples received before September 20. At a later time, I will send copies of analytical request sheets for water samples received since September 20.

B. M. Hughes

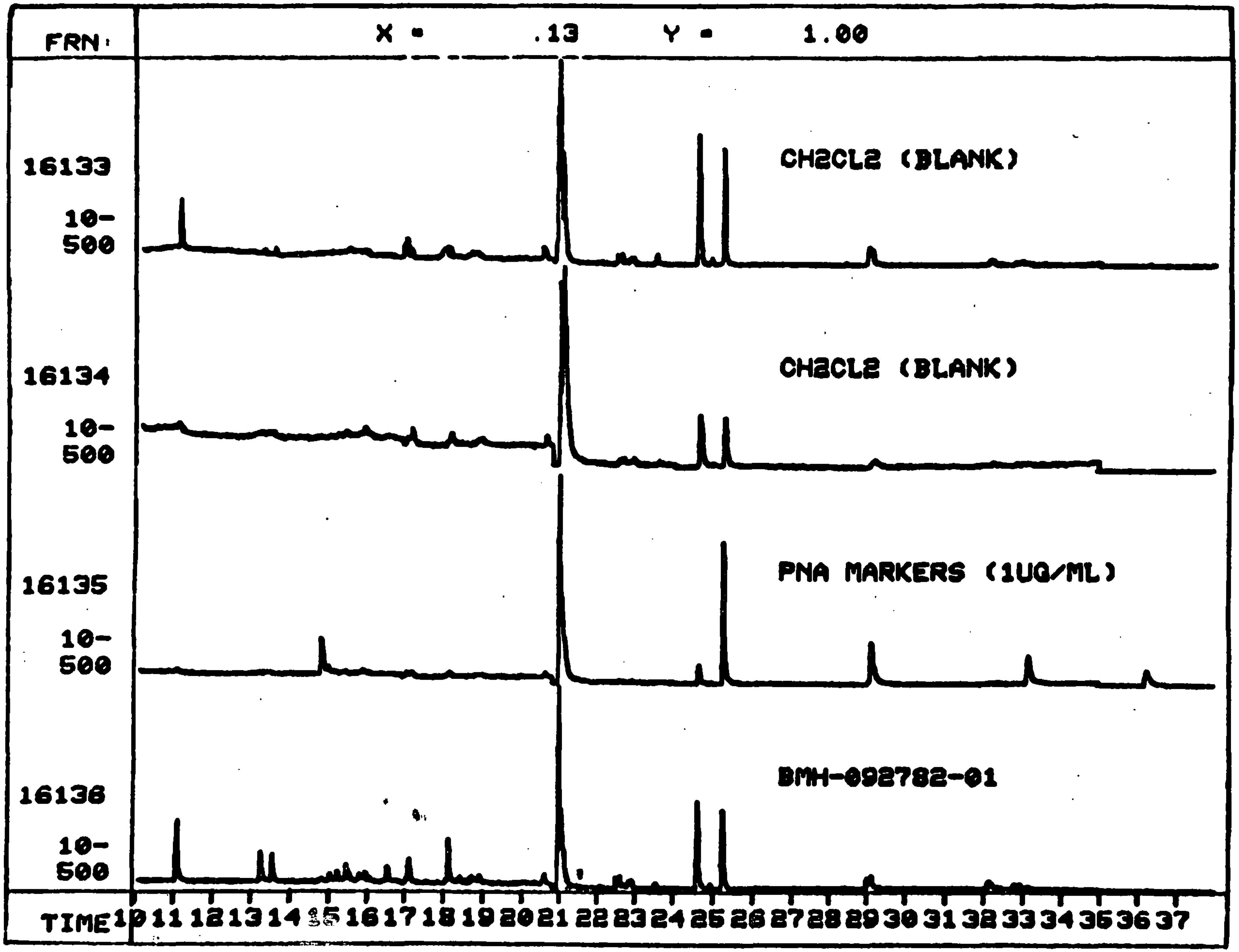
B. M. Hughes

BMH/cvd

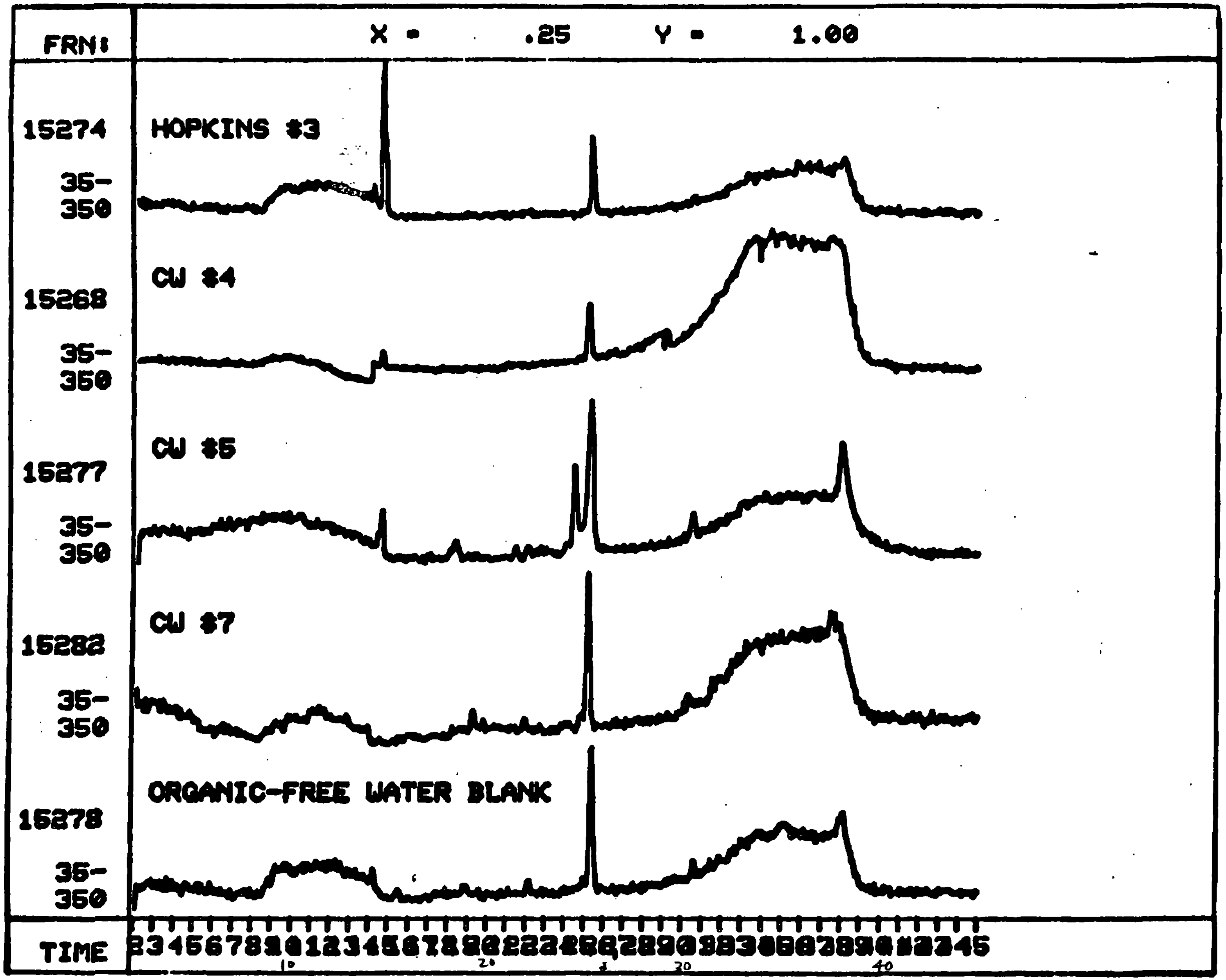
Enc.

106390

RC-10

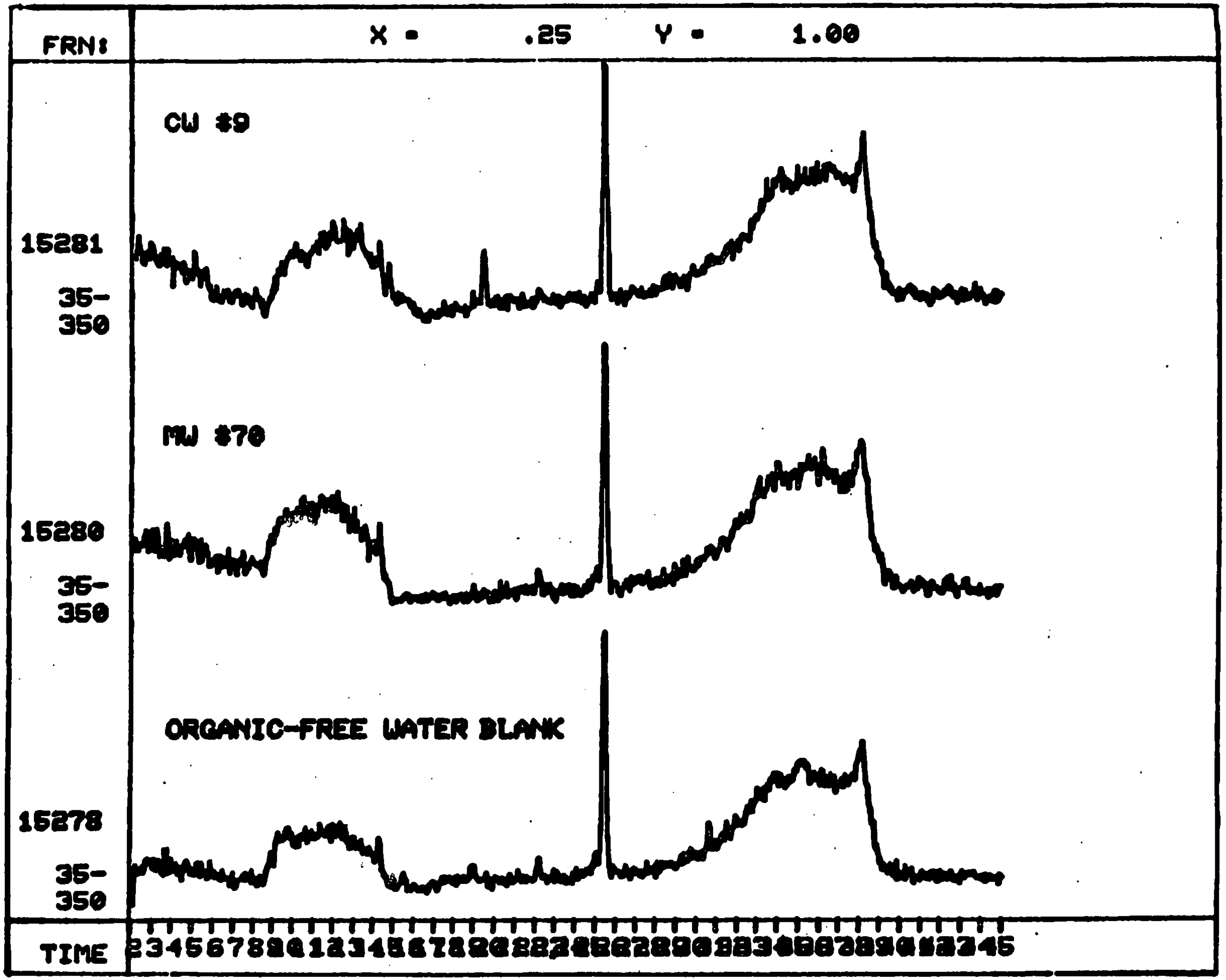


PNA Screen - QA/QC



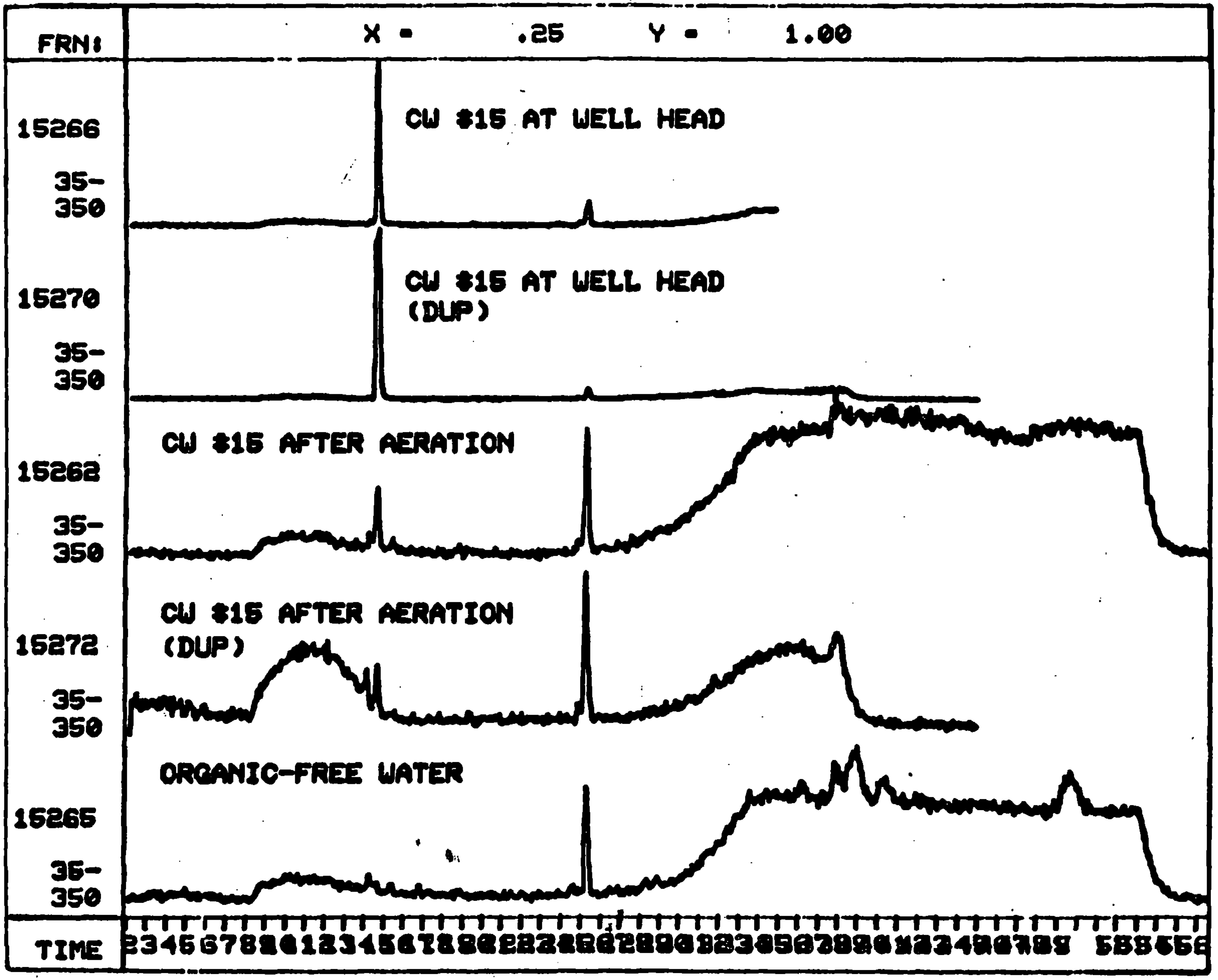
Volatile Wide Scan Screen - Cost Element A-3

ERT Task: 120



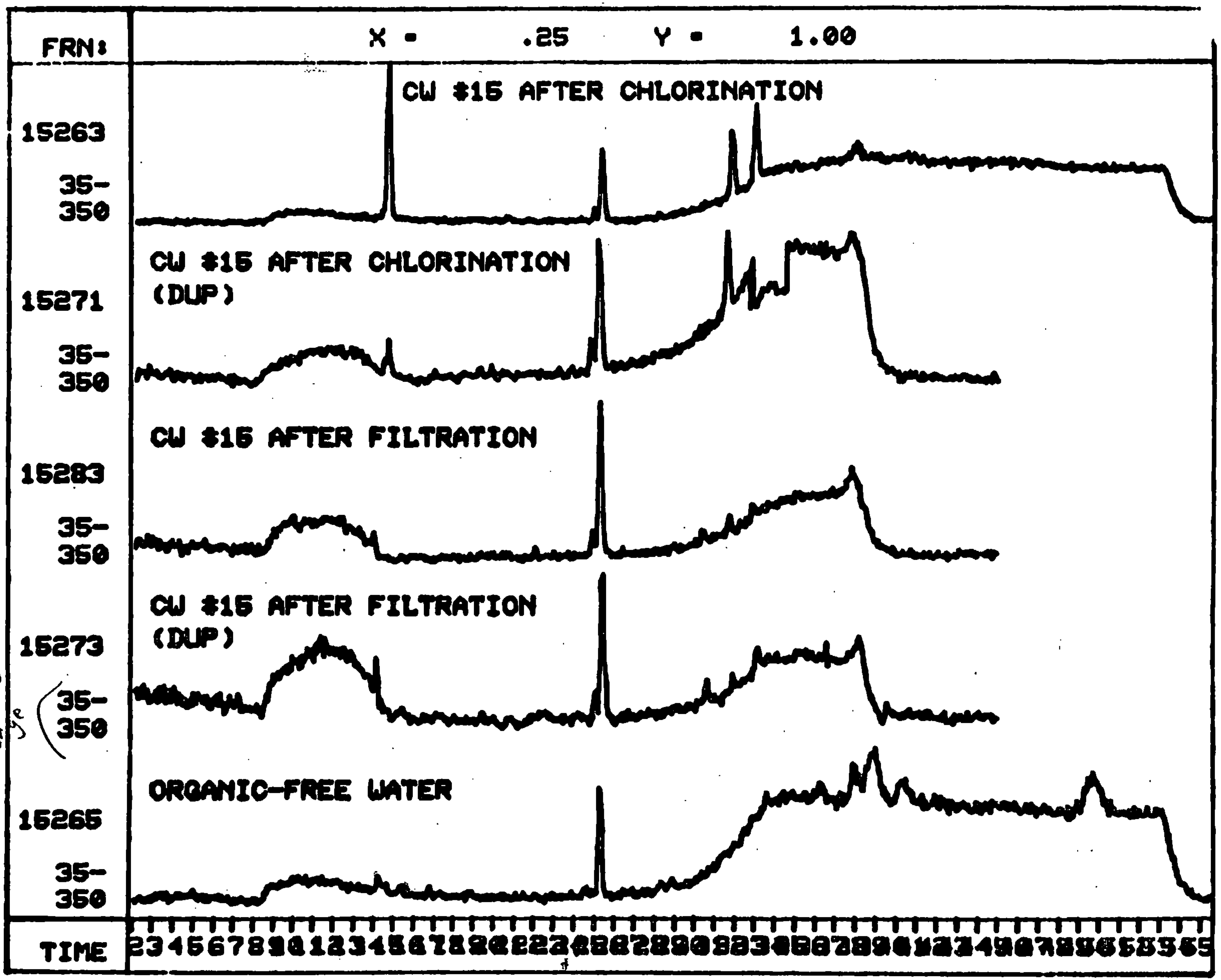
Volatile Wide Scan Screen - Cost Element A-3

ERT Task: 120



Volatile Wide Scan Screen - Cost Element A-3

ERT Task: 210



Volatile Wide Scan Screen - Cost Element A-3

ERT Task: 210

1063395

10/22/82
N.

MONSANTO RESEARCH CORPORATION

Inter-Office Correspondence

From LOCATION : B. M. Hughes, Dayton Laboratory

DATE : 22 October 1982

SUBJECT : Reilly Tar and Chemical Corp. Project

REFERENCE :

cc: John Craun (ERT)
Bill Roder (RTCC)
Files (MRC-Hughes)

RECEIVED

OCT 25 1982

ERT

TO : Gary Wilson
ERT
696 Virginia Road
Concord, Mass 01742

Incl 1) 9/82 SLP15 test
2) W23 samples
3) SLP4,5,7,9; H3; MW13 & 70 — In this file

Enclosed are PNA and wide-scan screening chromatograms for RTCC extraction numbers 106-129. In addition, I have enclosed a summary of documents which are contained in MRC's Reilly Tar and Chemical Corp. files. I will be sending you other deliverables as they become available, along with a set of MRC analytical request sheets for this project.

W13 analyses — (the full set of analyses ...ie. PDCJ wells are in the PDCJ file). well sampled Aug-Sept 1982

B. M. Hughes

B. M. Hughes

BMH/cvd

Encs.

106396

MRC will simply add to [illegible]

rec'd 10/14/82

I. SUMMARY OF REILLY TAR & CHEMICAL "ROUTINE" EXTRACTIONS AND ANALYSES

SAMPLE IDENTIFICATION	RTCC EXTRACTION NUMBER	COST ELEMENT[a]/BILLING MONTH[b]						
		A-1[c] Extraction	A-2 PNA Screen	A-3 Wide Scan Screen	B-1 Coal Tar Quant.	B-2 PNA Quant.	A-3 VOA Screen	B-3, B-4 Detailed MS Interpret
CW #15 (After chlorination)	106	1 (Sept)	1(Sept)	1(Sept)	1(Sept)	1(Sept)		
CW #15 (After chlorination and filtration)	107	1	1	1	1	1		
CW #15 (At well head)	108	1	1	1	1	1		
Method Blank	109	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #15 (At well head)	110	1	1	1	1	1		
CW #15 (After well head and aeration)	111	1	1	1	1	1		
CW #15 (After chlorination)	112	1	1	1	1	1		
CW #15(After chlorination and filtration)	113	1	1	1	1	1		
CW #15 (After well head and aeration)	114	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #4	115	1	1	1	1	1		
CW #7	116	1	1	1	1	1		
MW #70	117	1	1	1	1	1		
MW #13	118	1	1	1	1	1		
CW #9	119	1	1	1	1	1		

[a] Number of cost element indicates the number of samples or fractions being billed in each category. N.C. indicates no charge for this unit (A certain number of Quality Control Samples are indicated).

[b] Billing month indicates the actual month in which charges for the fraction/cost unit are made.

[c] Key for cost unit charges (refer to 22 September 1982 letter and estimates to John Craum for full explanations).
A-1 = $210/s[illegible]le; A-2 = $159/sample; A-3 = $159/sample; B-1 = $200/sample; B-2 = $200/s[illegible]le; B-3, B-4 = $600/s[illegible]le.

1065337

I.

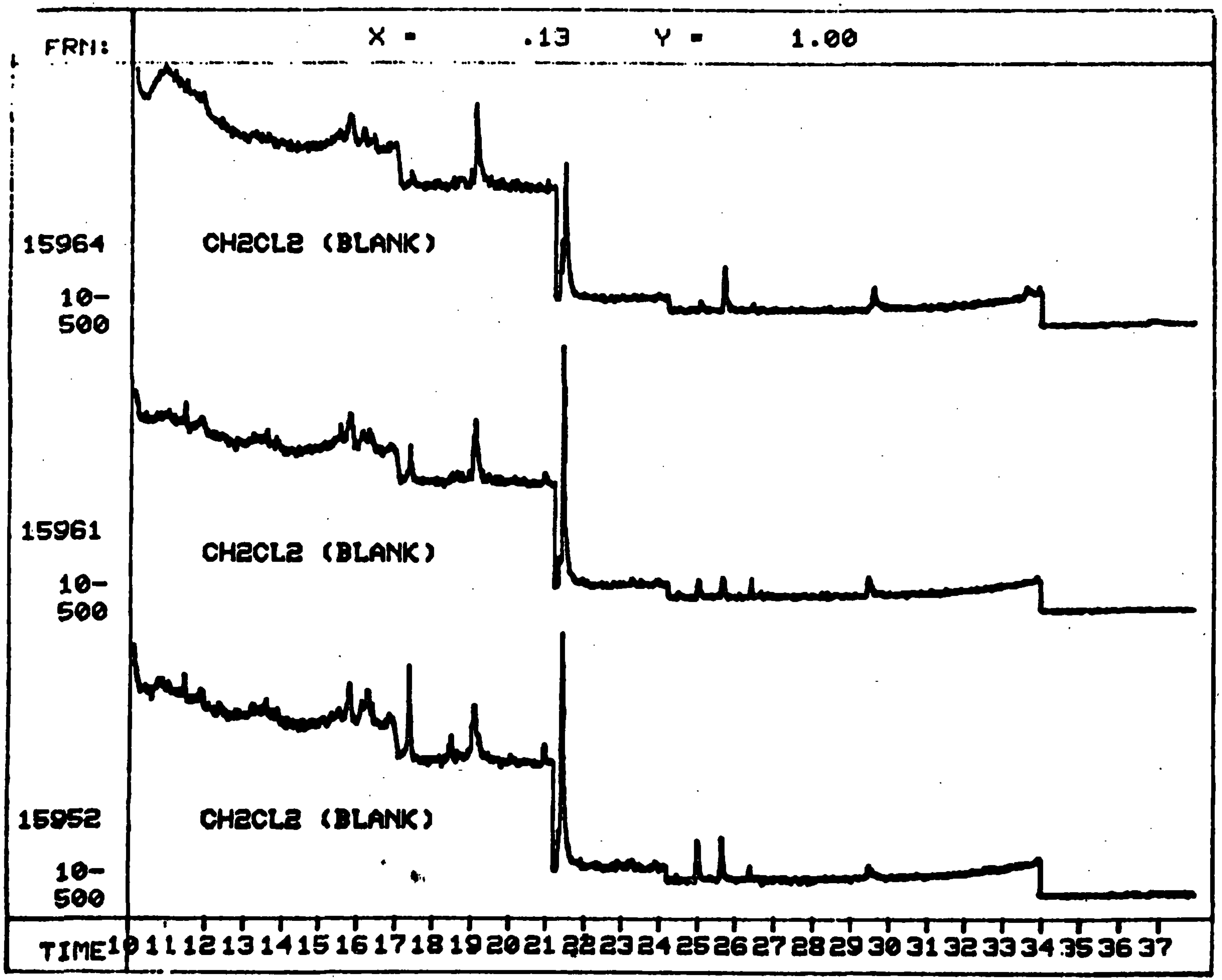
SUMMARY OF REILLY TAR & CHEMICAL "ROUTINE" EXTRACTIONS AND ANALYSES

SAMPLE IDENTIFICATION	RTCC EXTRACTION NUMBER	COST ELEMENT[a]/BILLING MONTH[b] A-1[c] Extraction	A-2 PNA Screen	A-3 Wide Scan Screen	B-1 Coal Tar Quant.	B-2 PNA Quant.	A-3 VOA Screen	B-3, B-4 Detailed MS Interpret
Method Blank	120	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #5	121	1	1	1	1	1		
Hopkins Well #3	122	1	1	1	1	1		
Deionized Water Spiked with Coal Tar	123	1	1	1	1	1		
Well #23 9/14/82 15:00	124	1	1	1	1	1		
Well #23 9/17/82 16:30	125	1	1	1	1	1		
Well #23 9/17/82 16:30	126	1	1	1	1	1		
Method Blank	127	N.C	N.C	N.C	N.C	N.C		
Well #23 7/29/82 861'	128	1	1	1	1	1		
Well #23 8/7/82 804.5'	129	1	1	1	1	1		

[a] Number of cost element indicates the number of samples or fractions being billed in each category. N.C. indicates no charge for this unit (A certain number of Quality Control Samples are indicated).

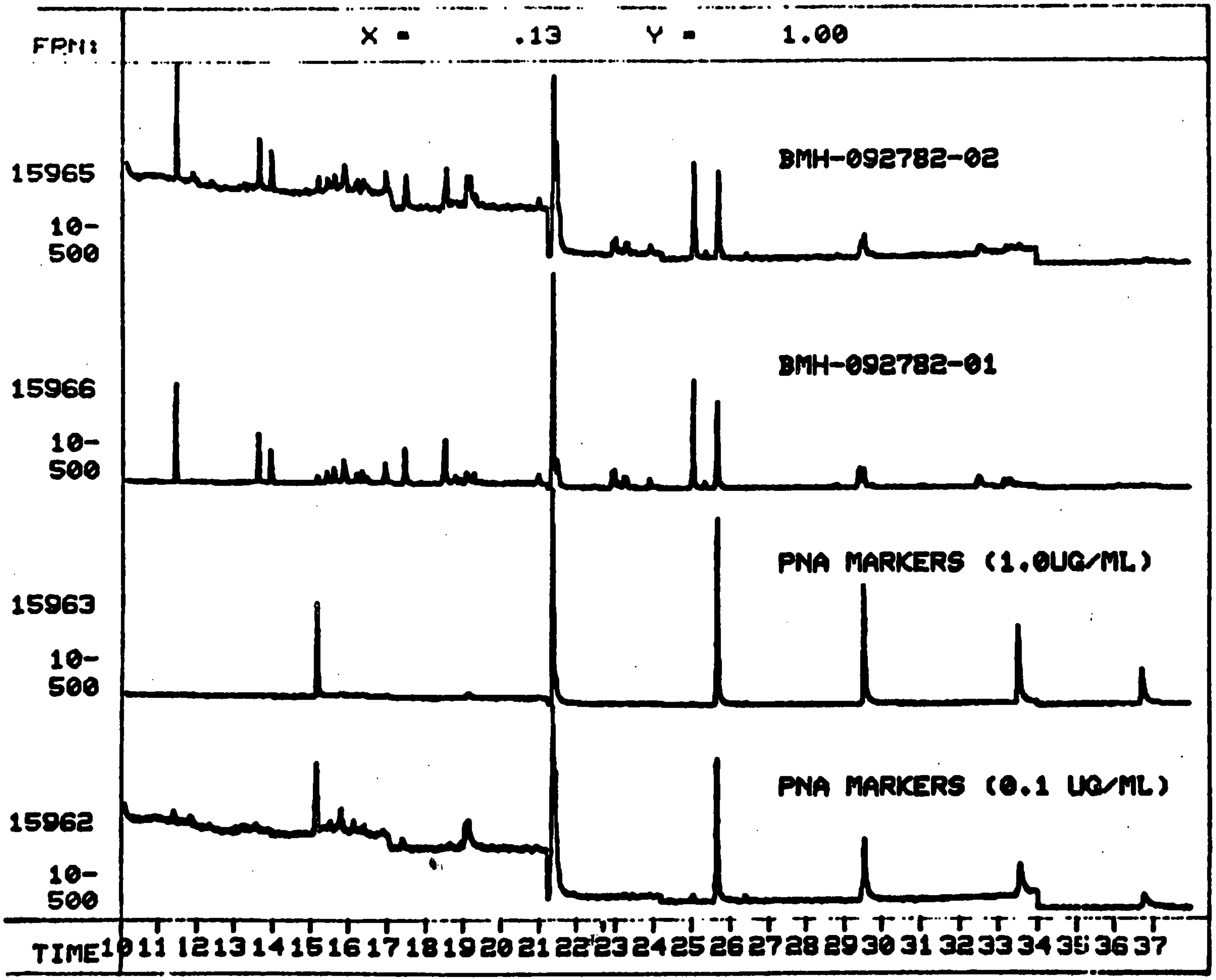
[b] Billing month indicates the actual month in which charges for the fraction/cost unit are made.

[c] Key for cost unit charges (refer to 22 Sept er 1982 letter and estimates to John Craun for full explanations).
A-1 = $210/sample; A-2 = $159/sample; A-3 = $159/sample; B-1 = $200/sample; B-2 = $200/sample; B-3, B-4 = $600/s le.



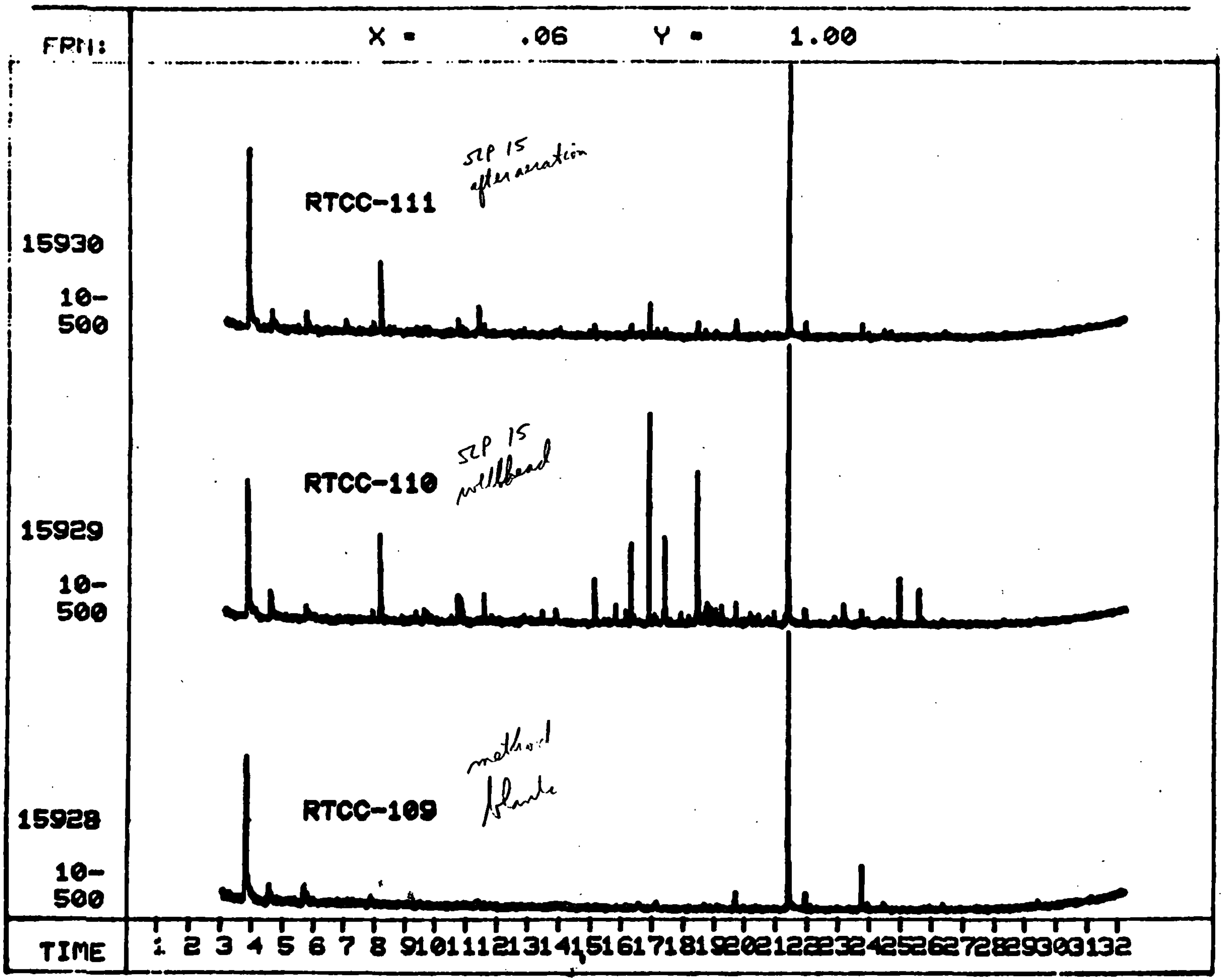
PNA Screen - QA/QC

106399



PNA Screen - QA/QC

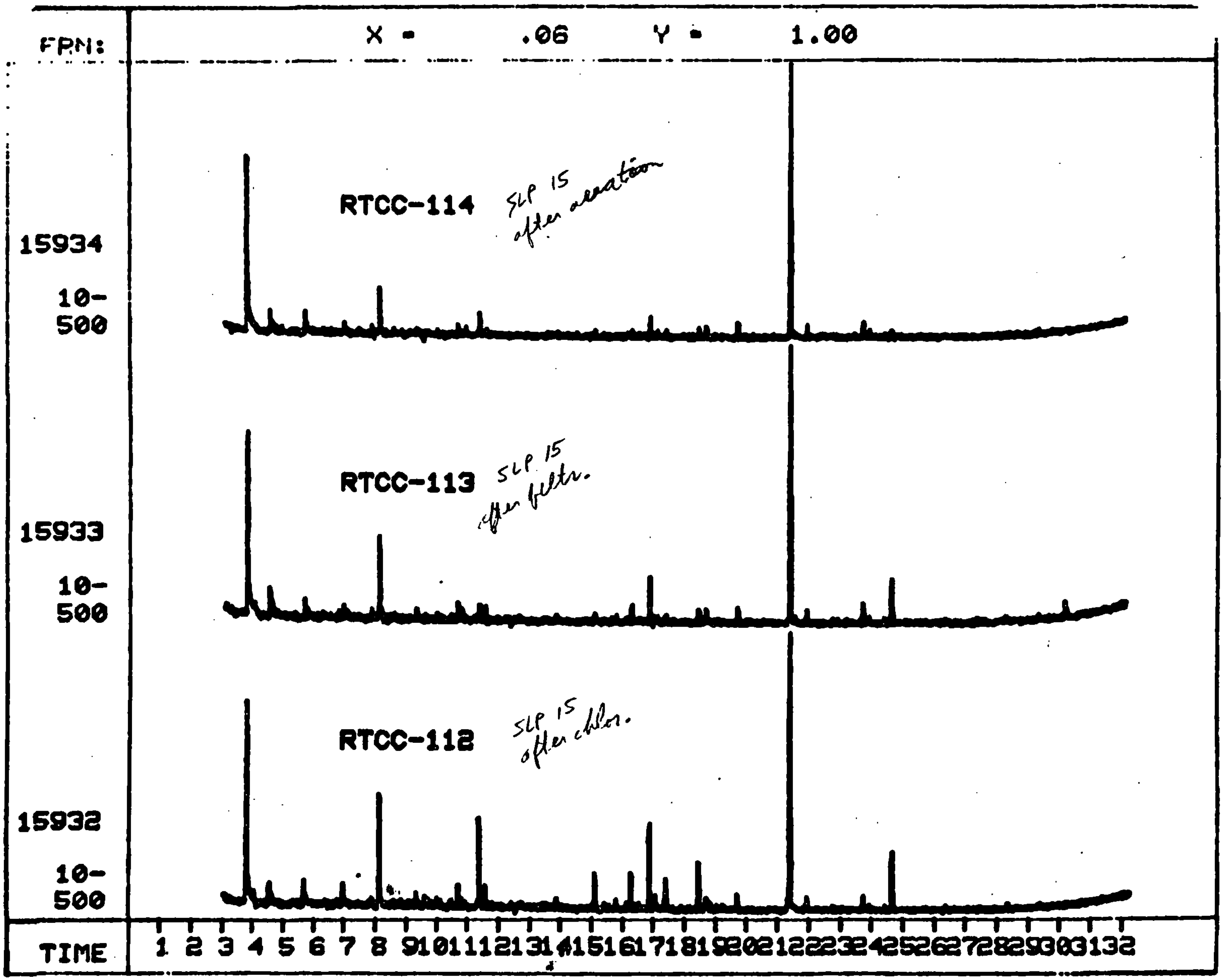
106400



Wide Scan Screen - Cost Element A-3

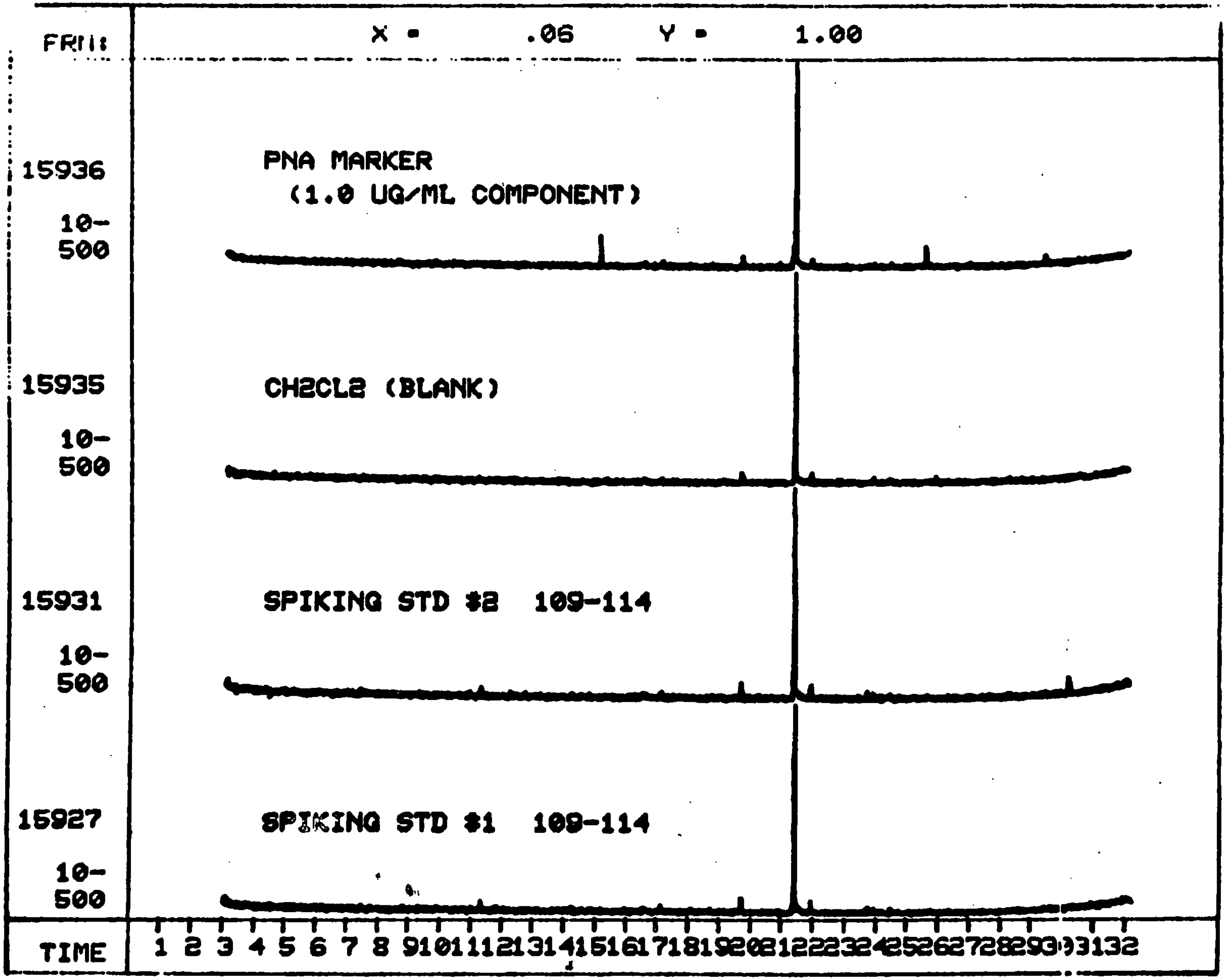
ERT Task: 210

106401



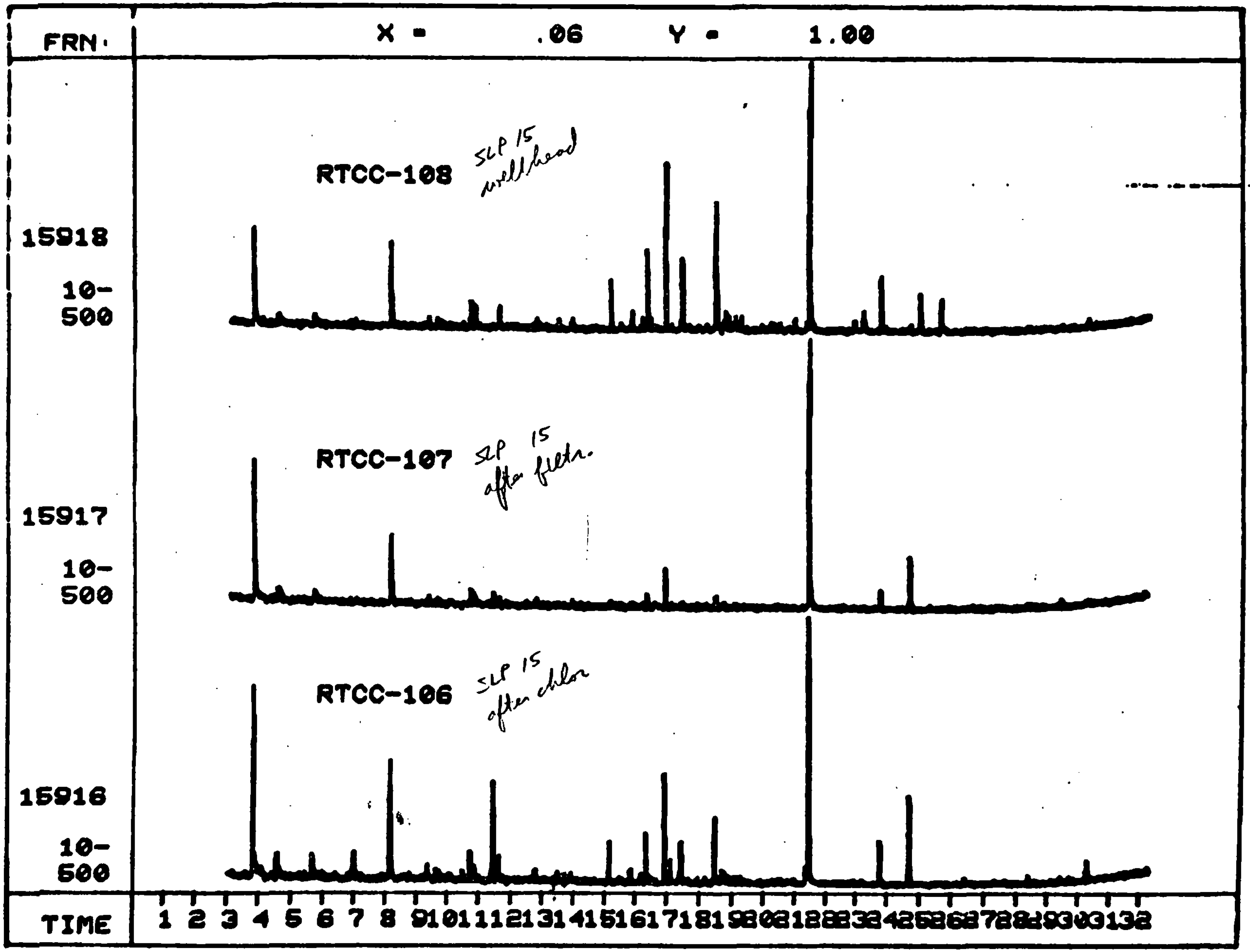
Wide Scan Screen - Cost Element A-3

ERT Task: 210

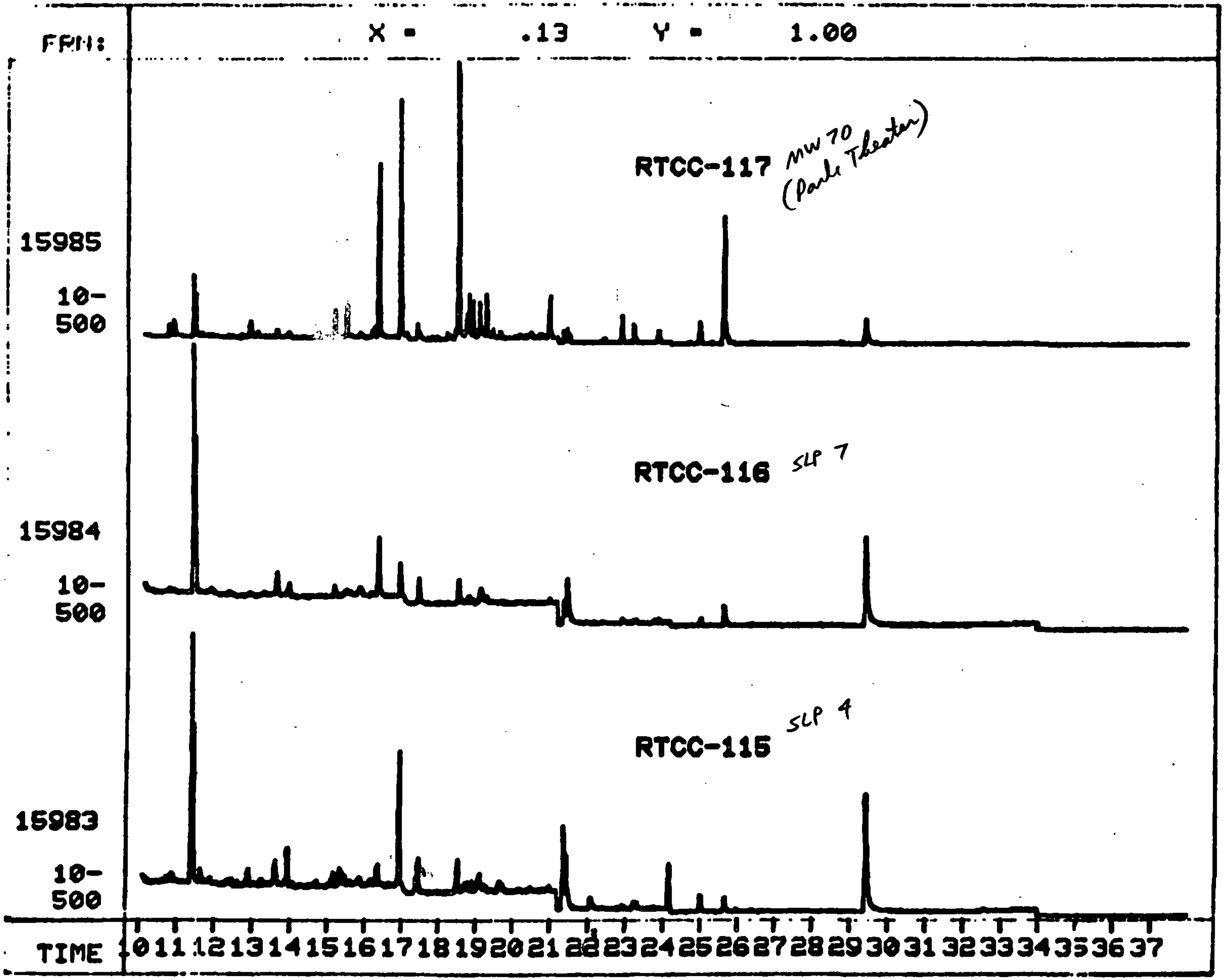


Wide Scan Screen - QA/QC

1064403



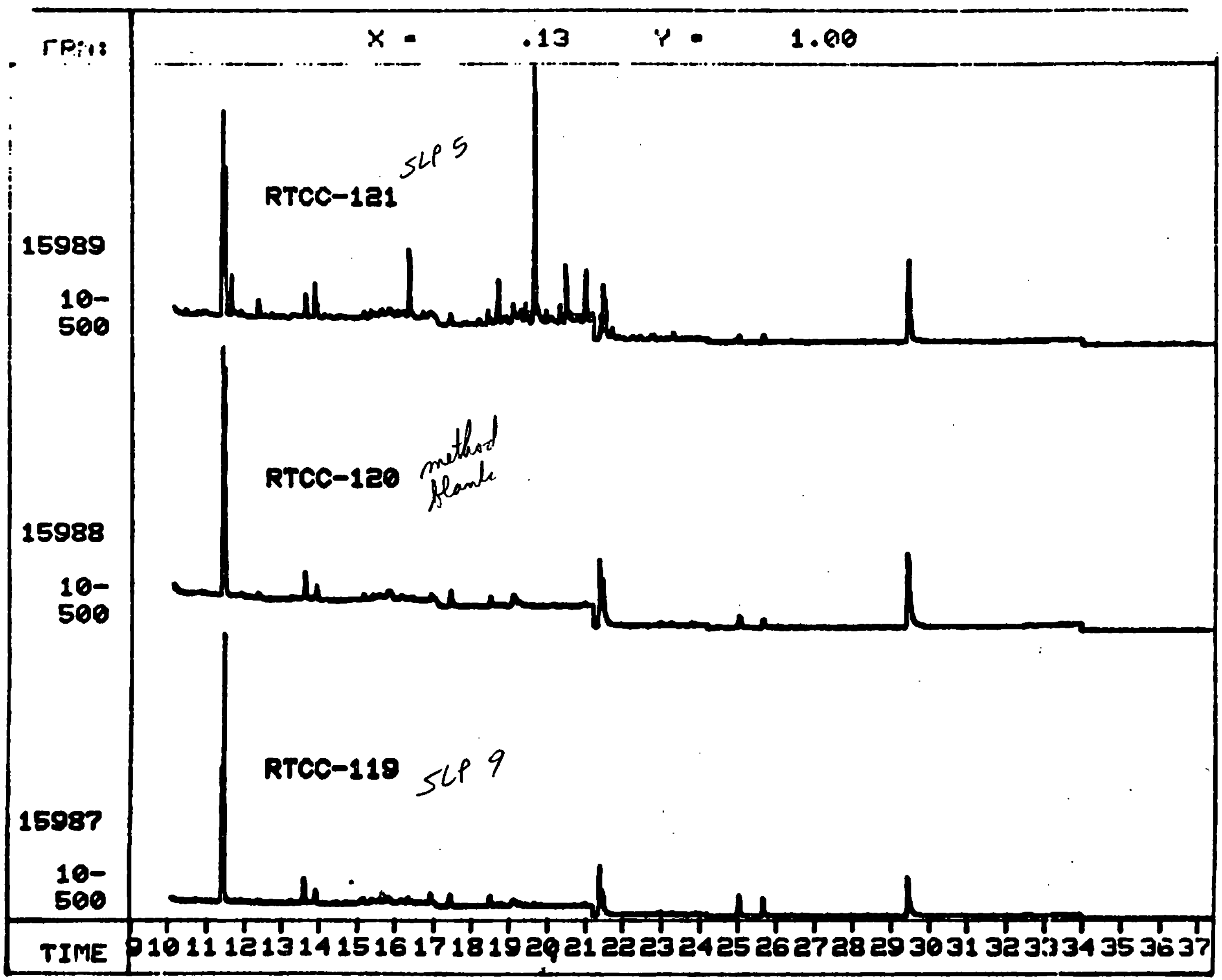
Wide Scan Screen - Cost Element A-3



PNA Screen - Cost Element A-2

ERT Task: 120

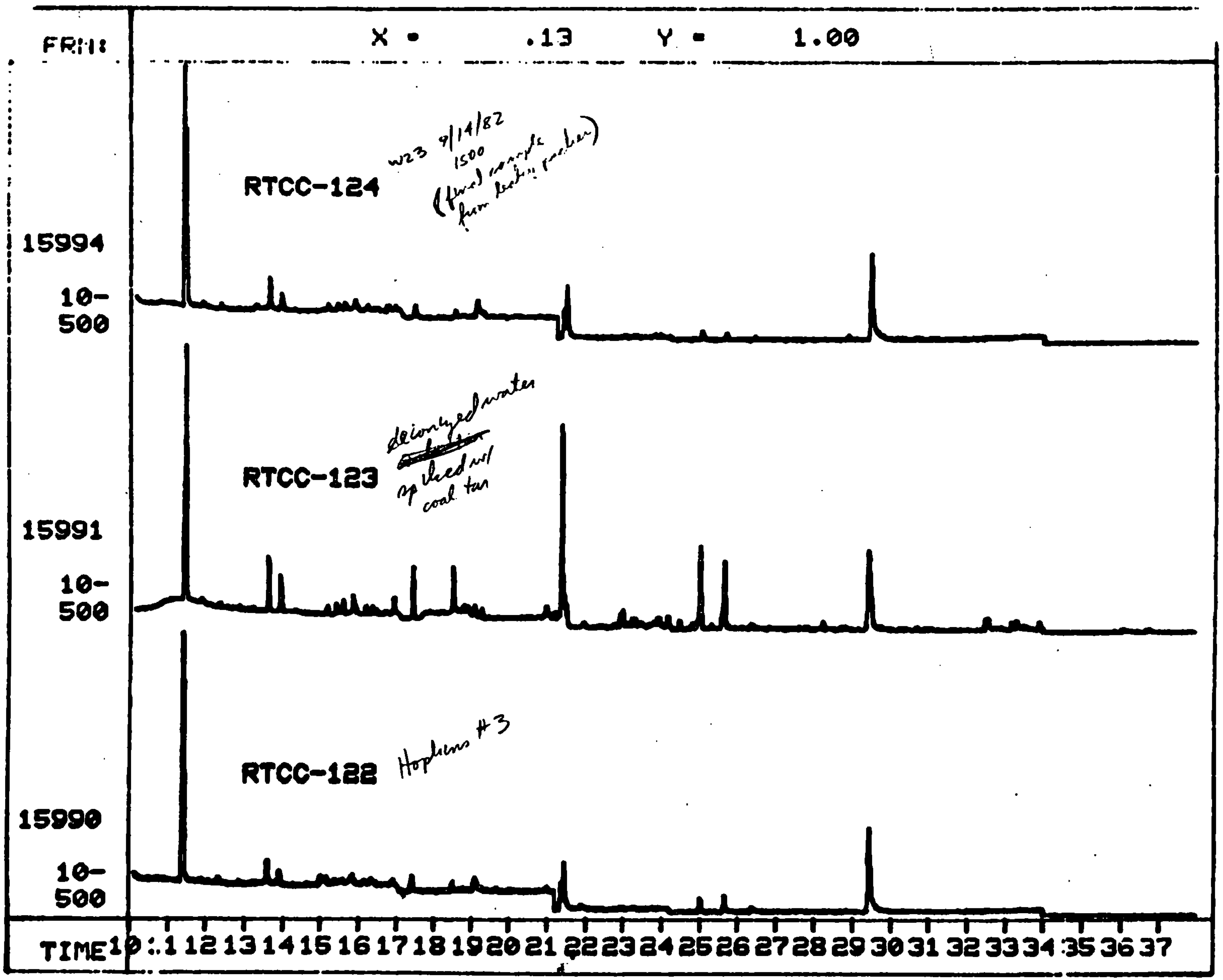
1064405



PNA Screen - Cost Element A-2

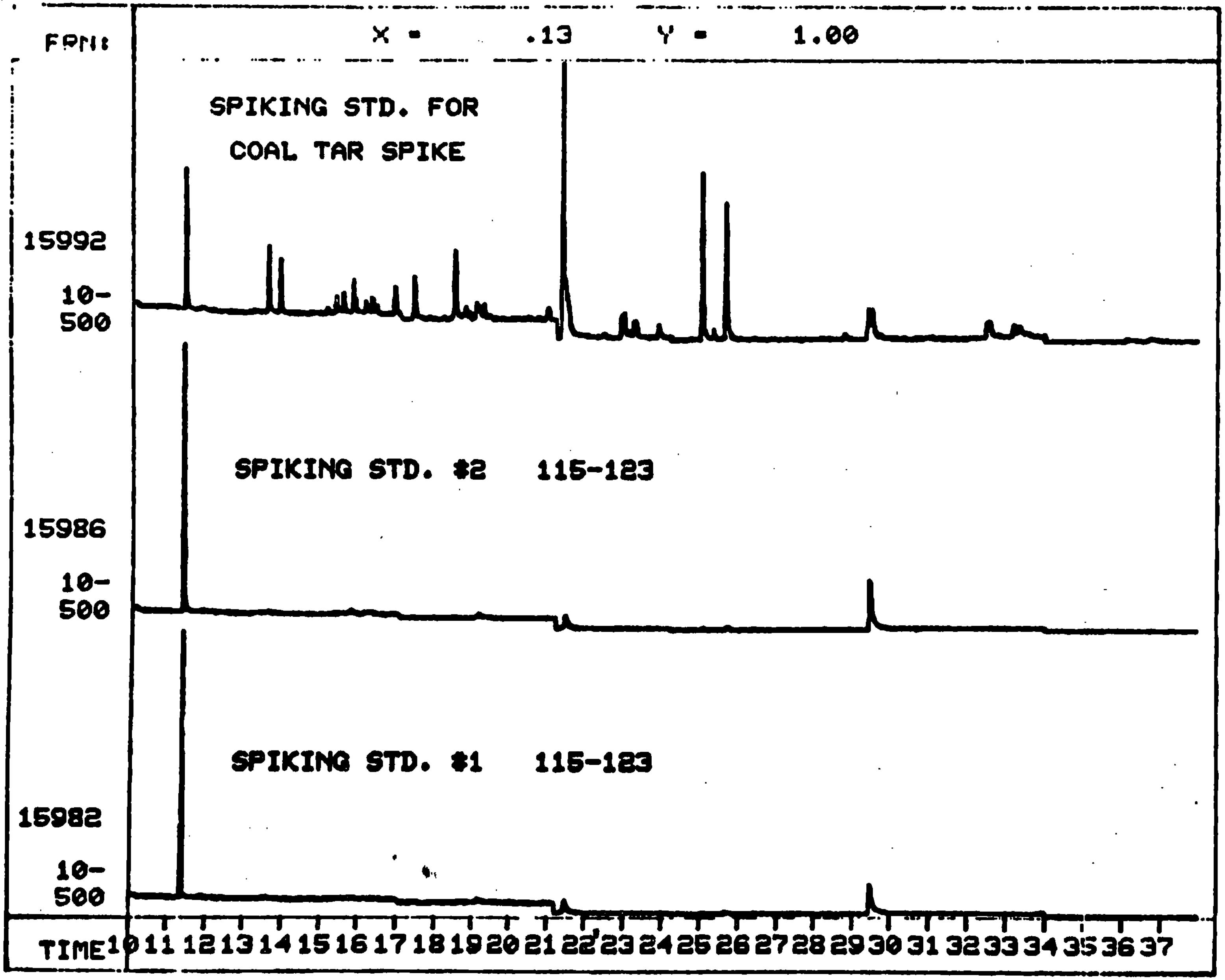
ERT Task: 120

1054406

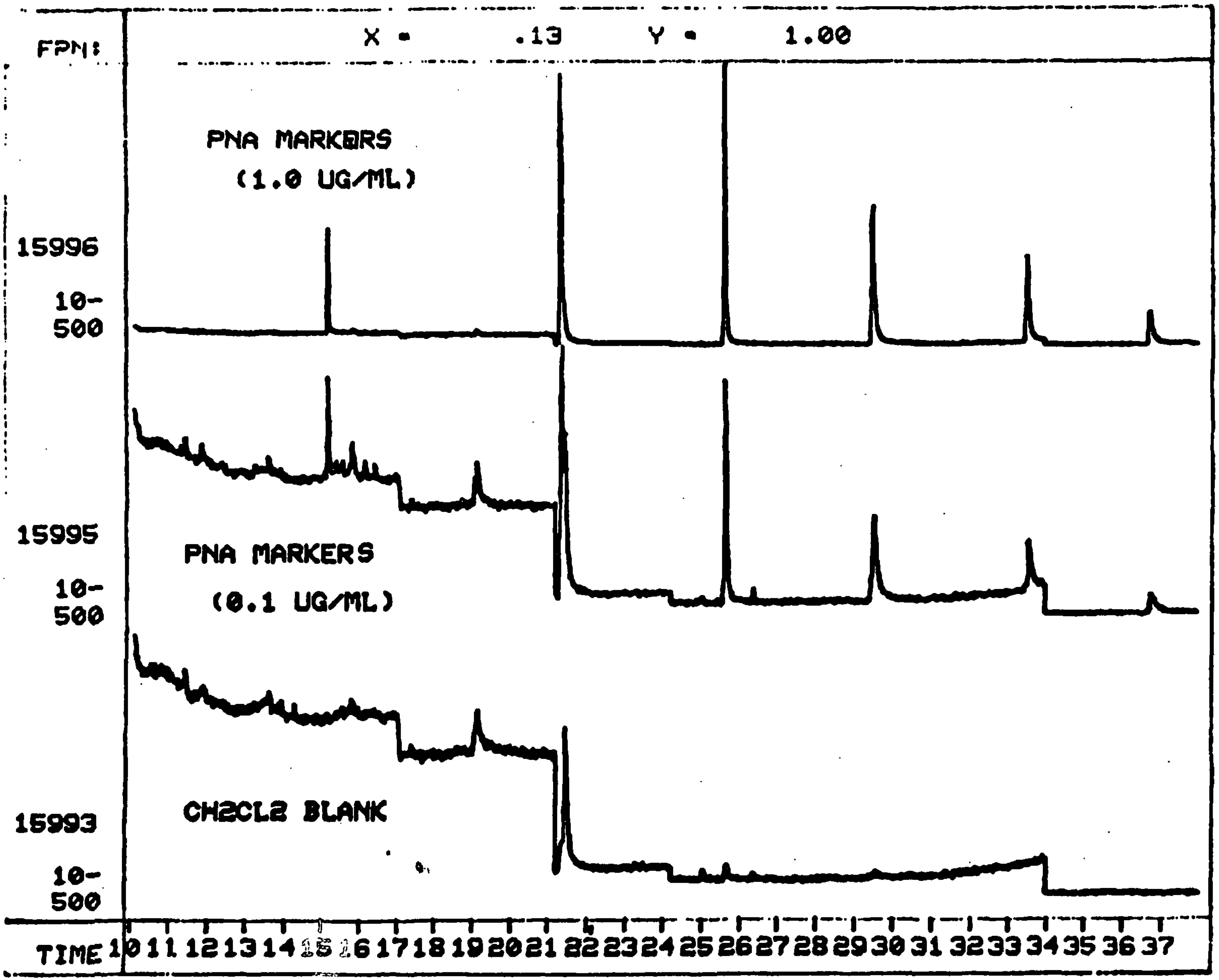


PNA Screen - Cost Element A-2

ERT Task: 120,220

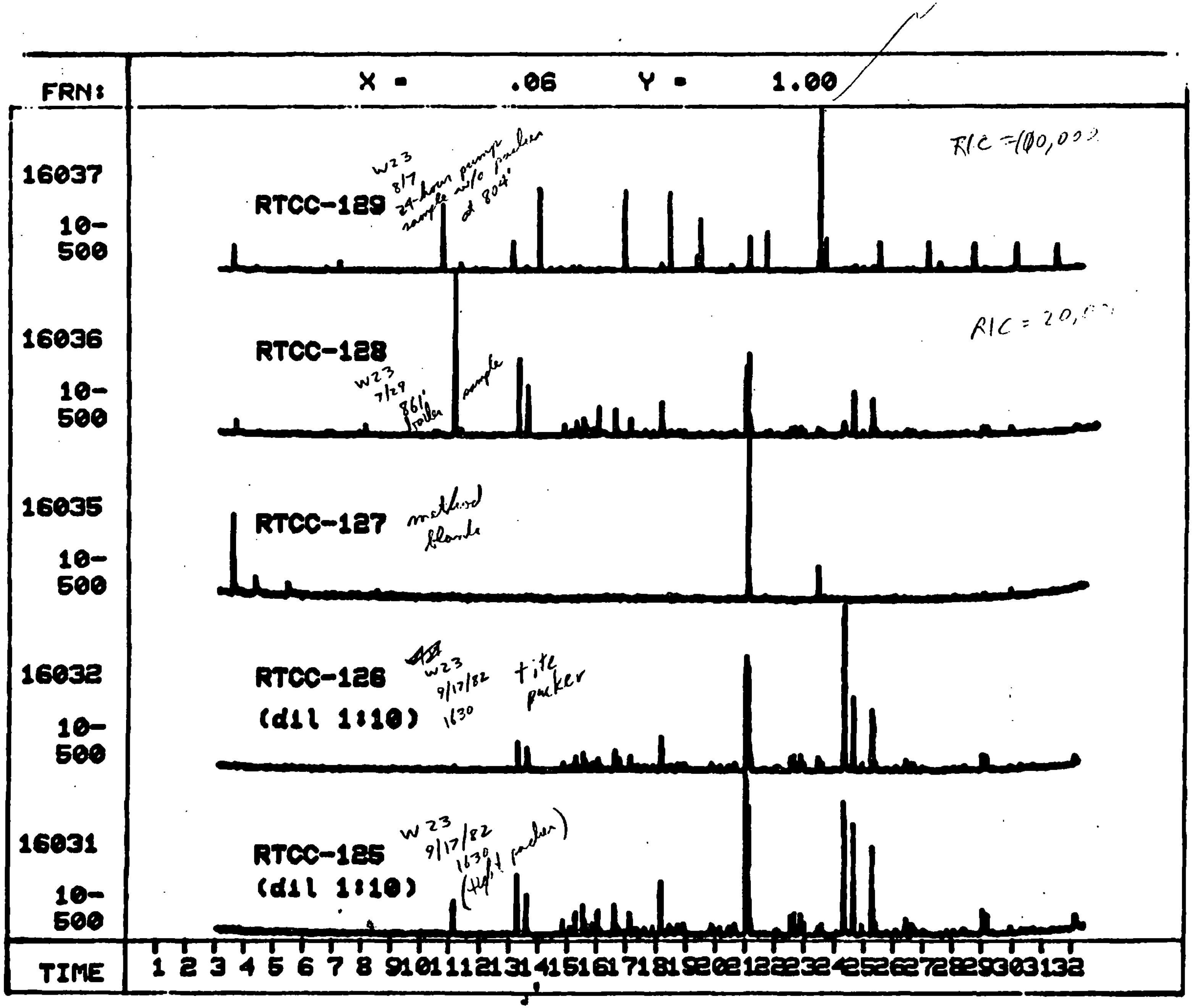


PNA Screen - QA/QC



PNA Screen - QA/QC

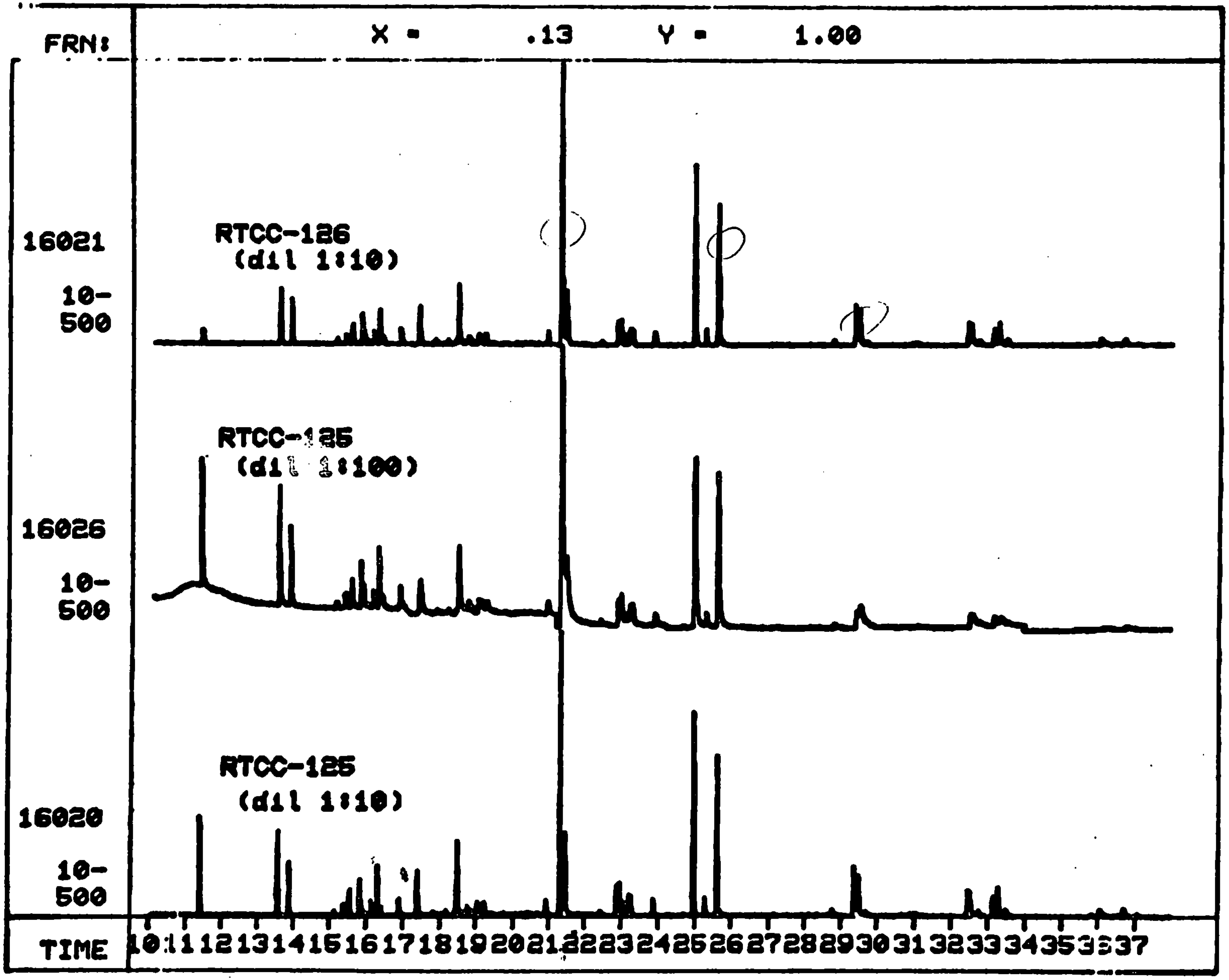
1064409



Wide Scan Screen - Cost Element A-3

ERT Task: 220

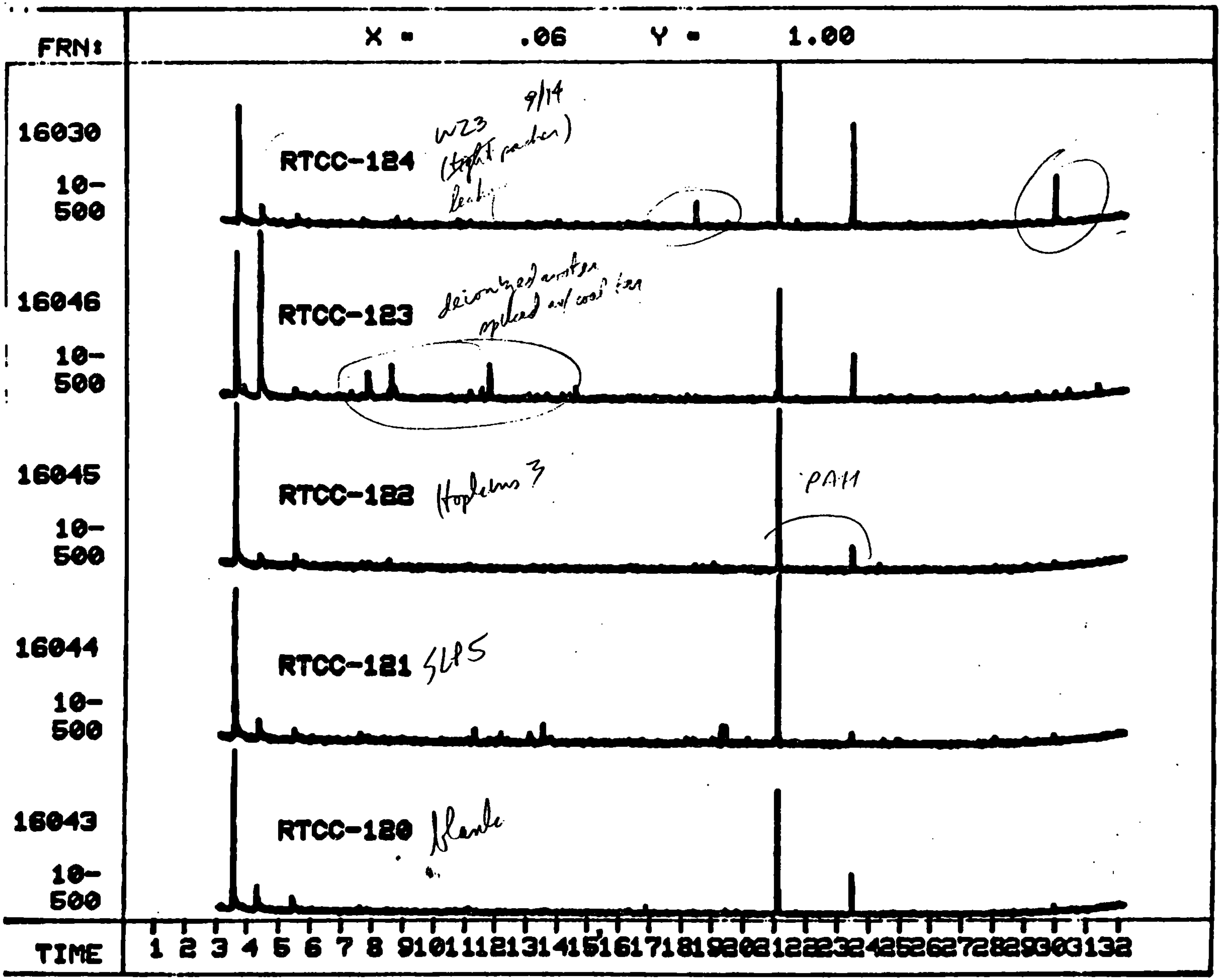
Tite packer



PNA Screen - Cost Element A-2

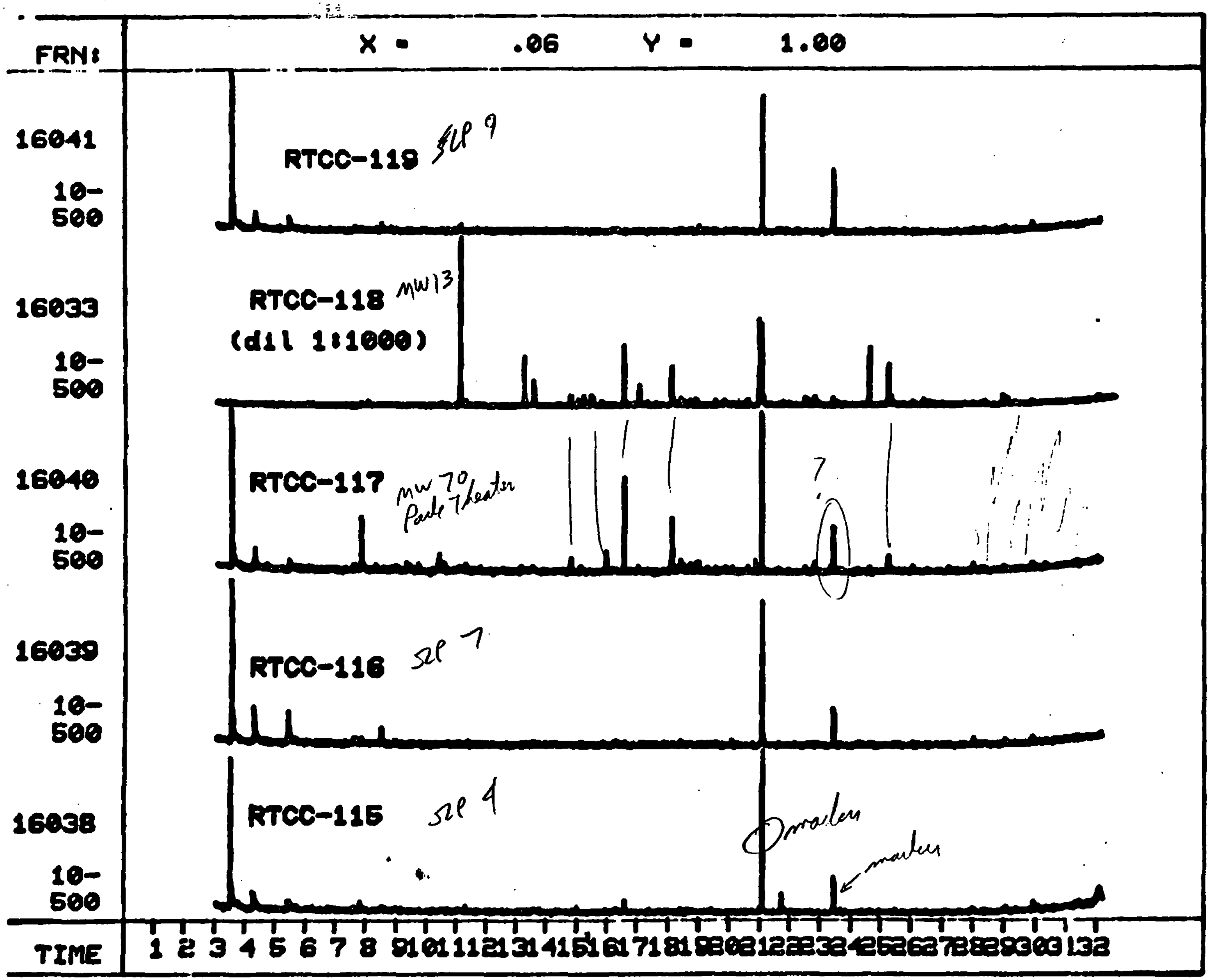
ERT Task: 220

106411



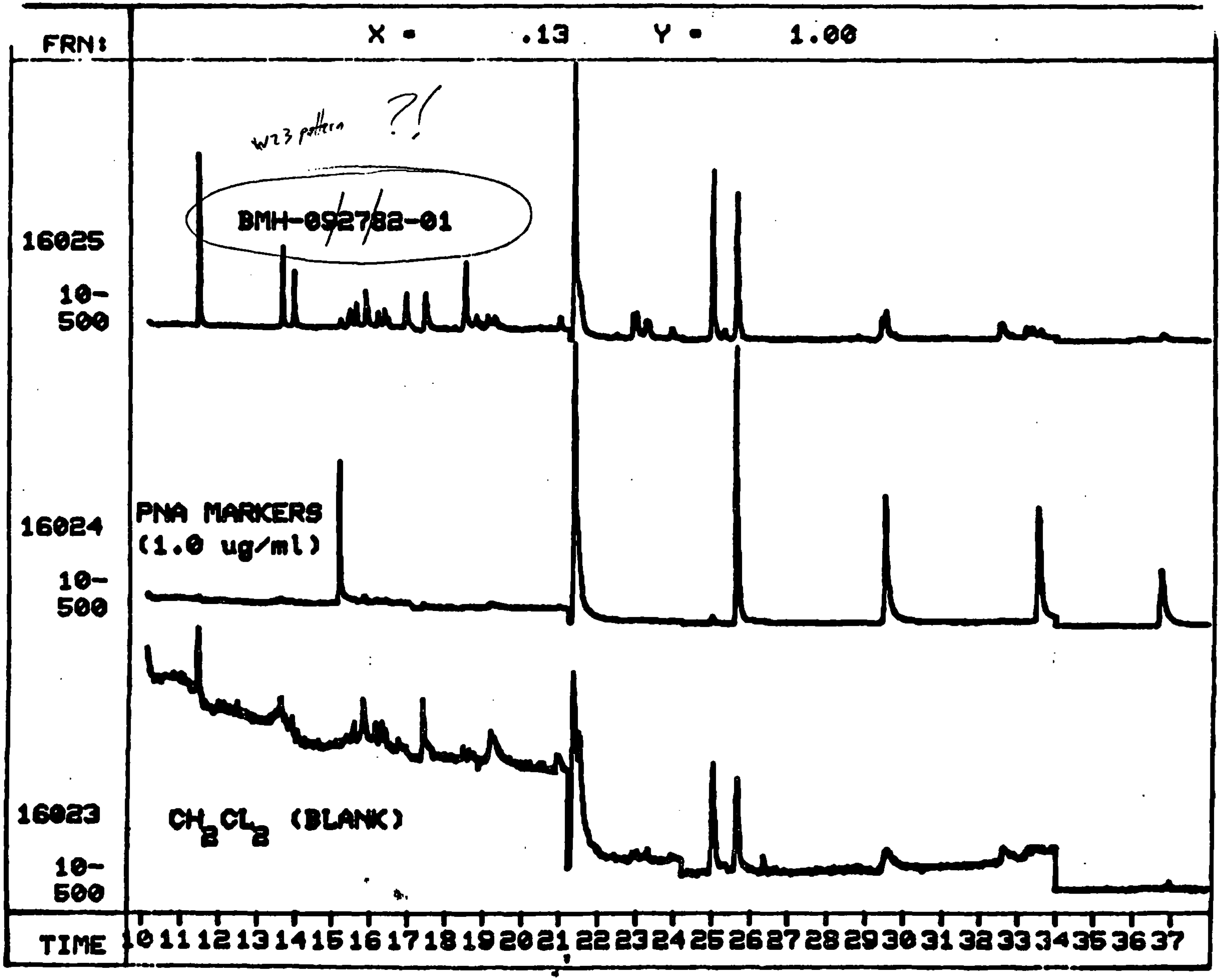
Wide Scan Screen - Cost Element A-3

ERT Task: 120,220



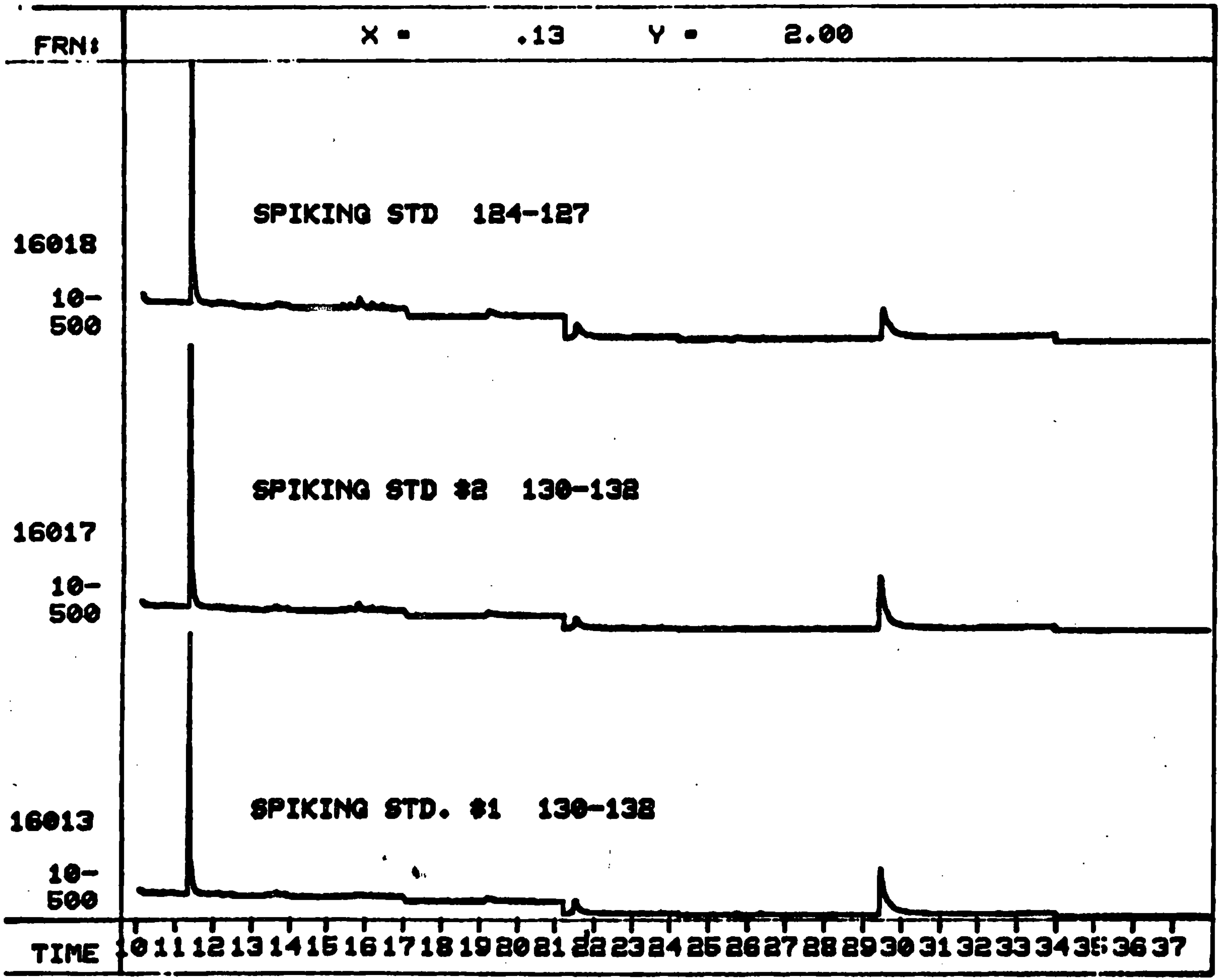
Wide Scan Screen - Cost Element A-3

ERT Task: 120



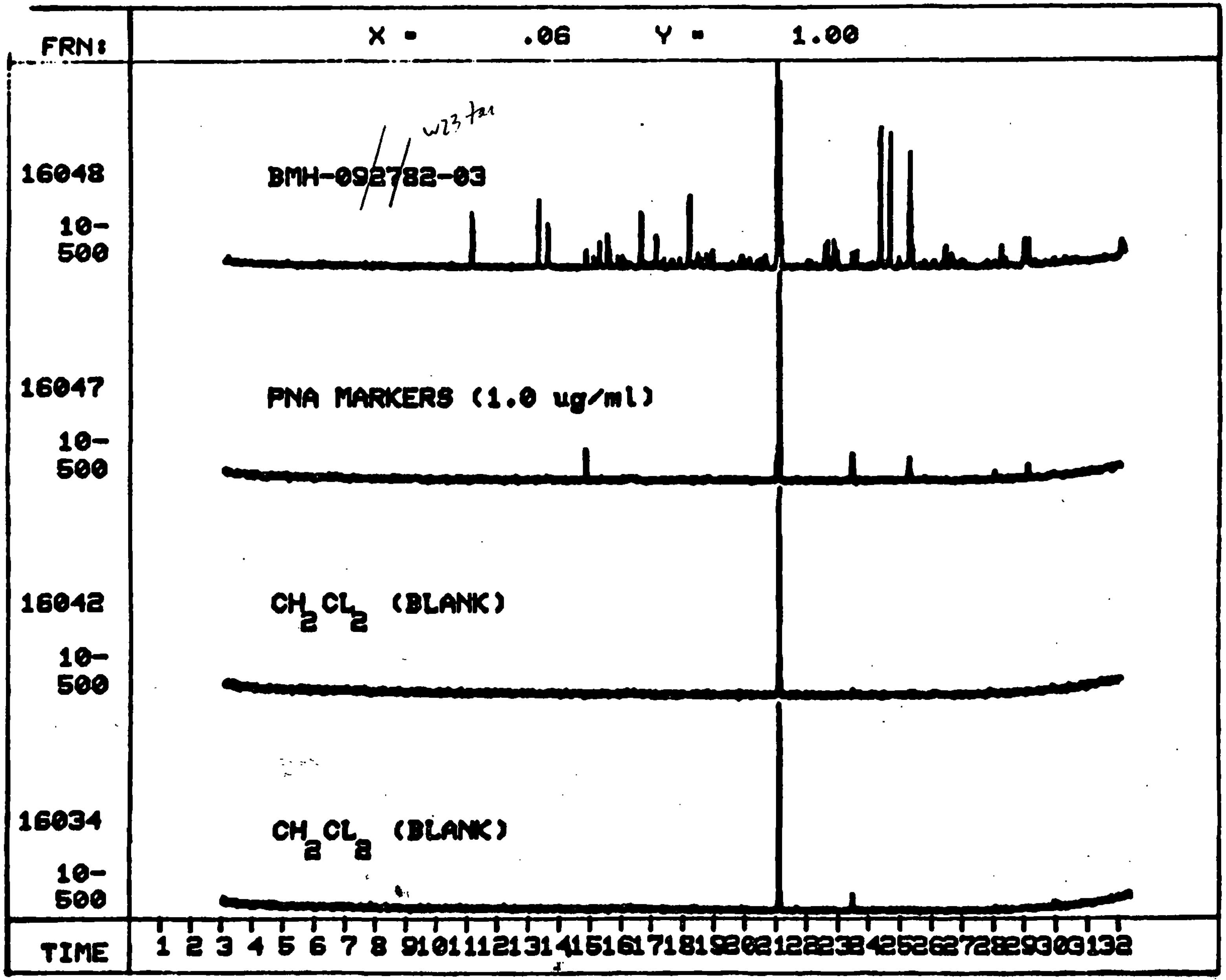
PNA Screen - QA/QC

1056414



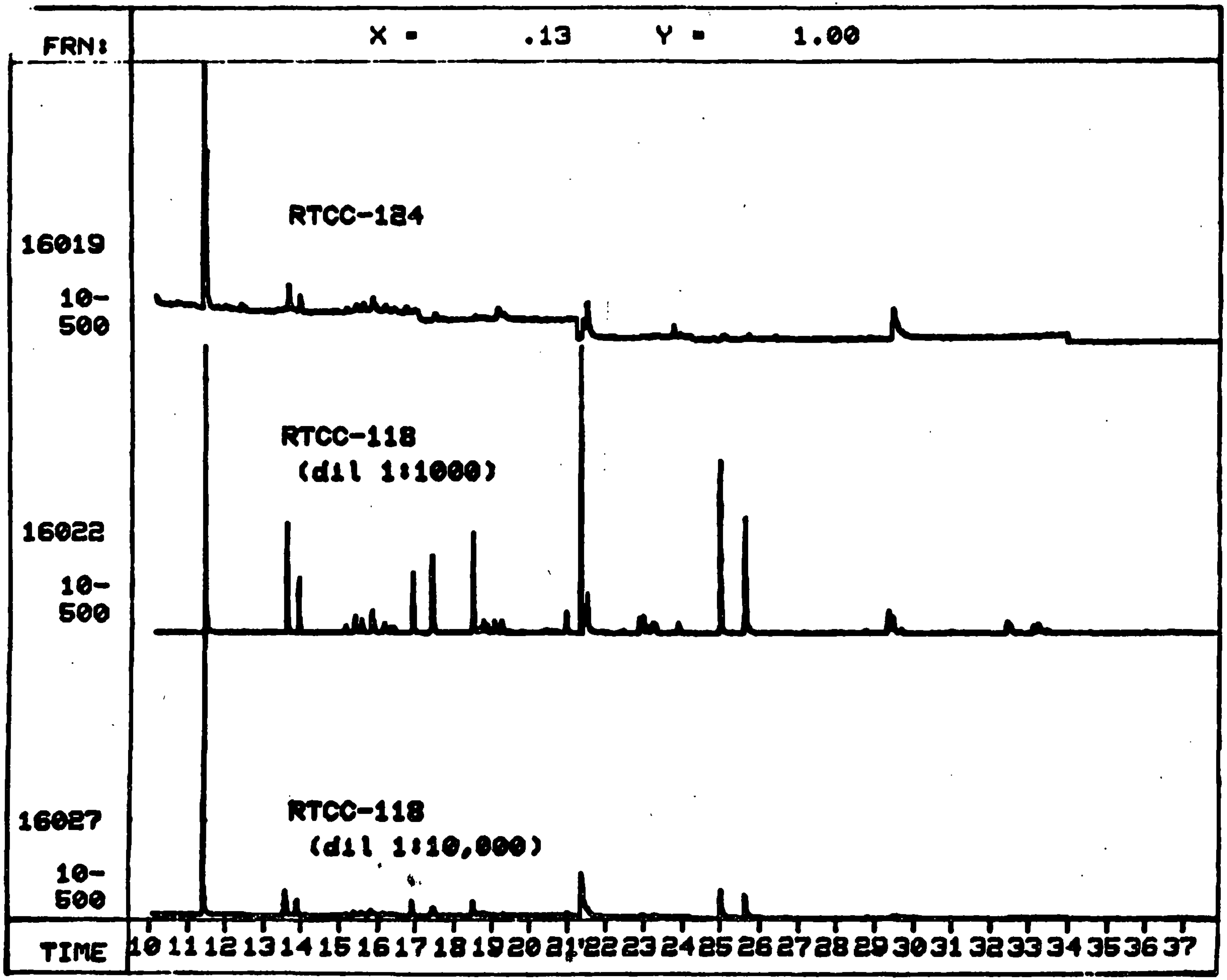
PNA Screen - QA/QC

1064415



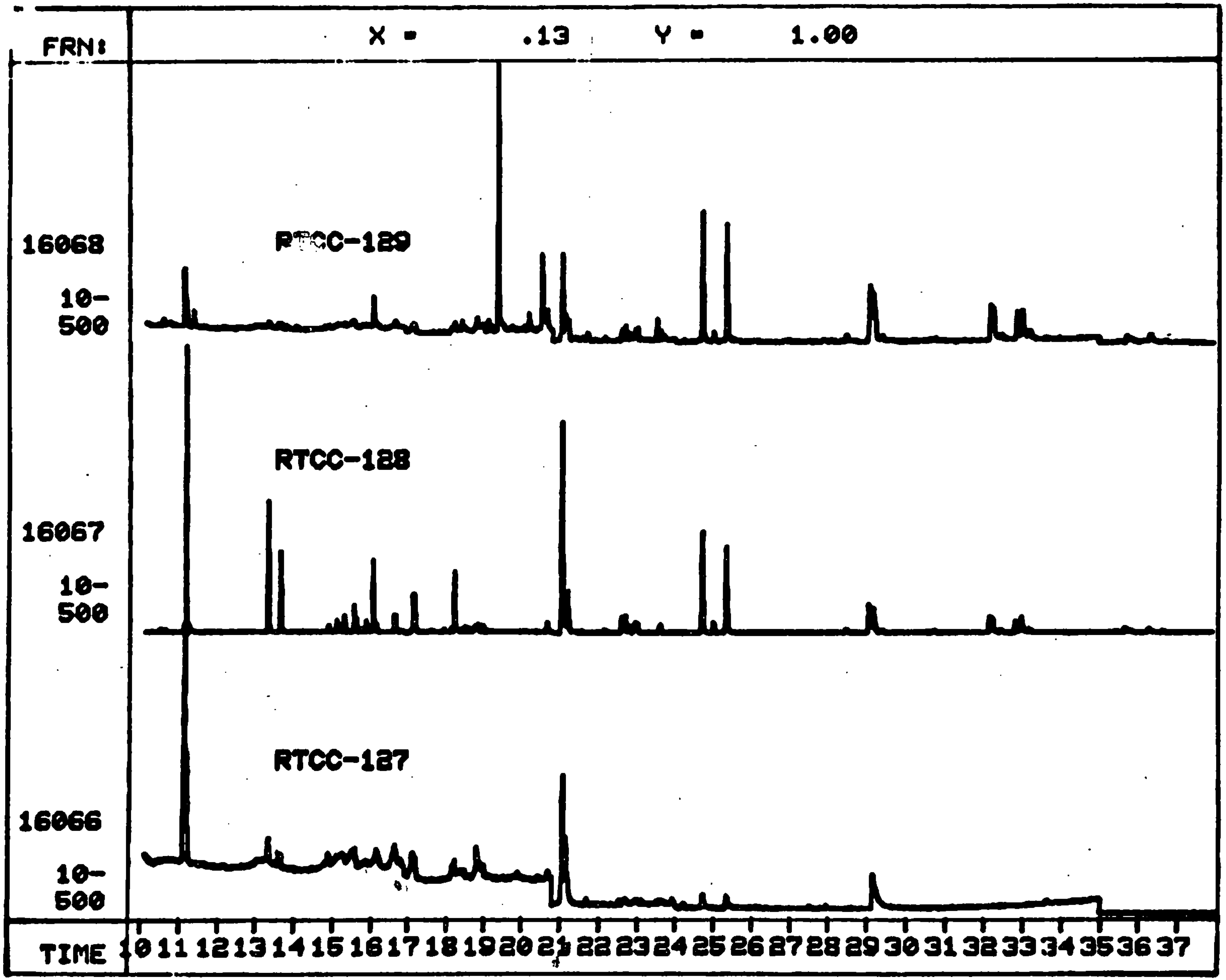
Wide Scan Screen - QA/QC

406416



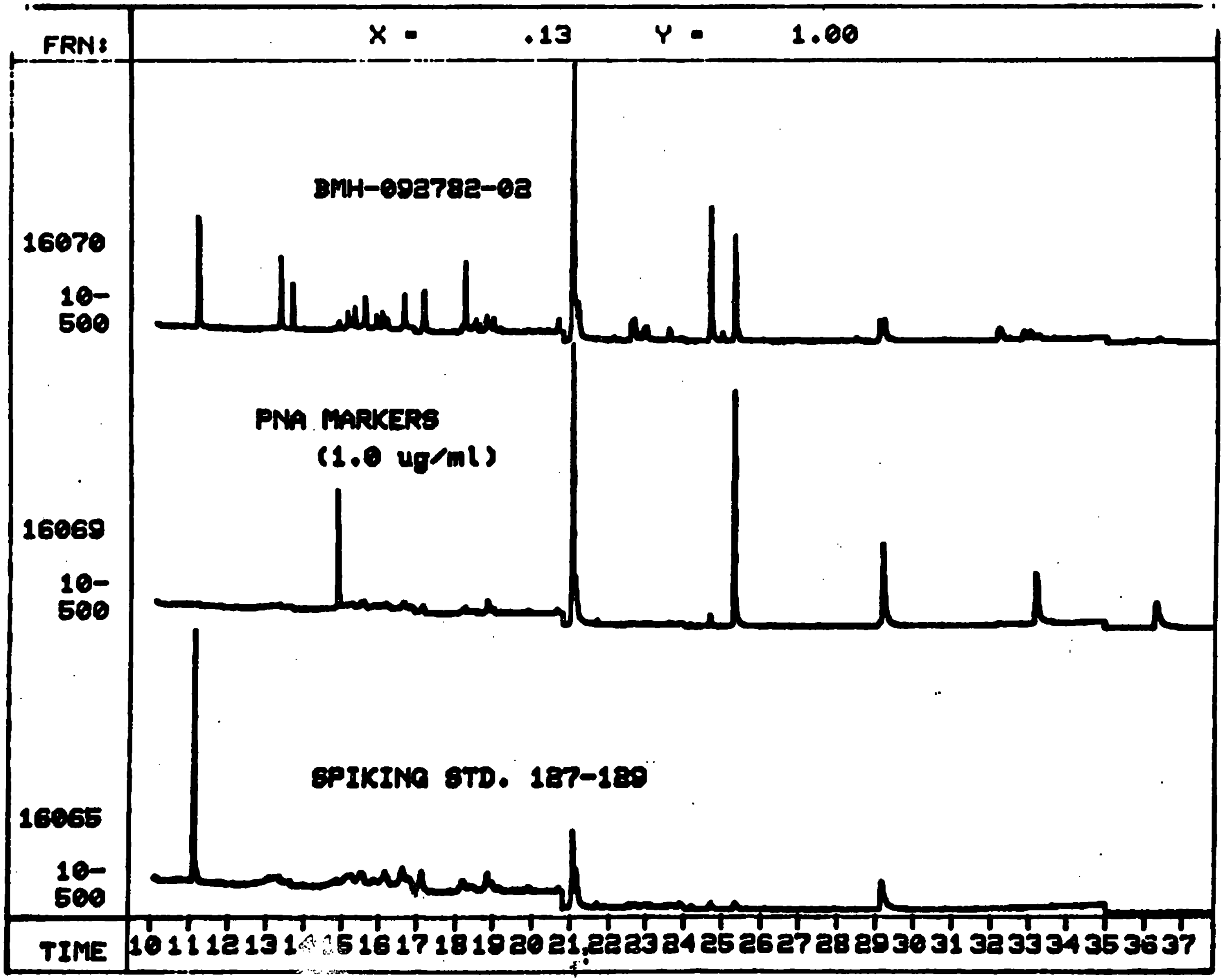
PNA Screen - Cost Element A-2

ERT Task: 120,220



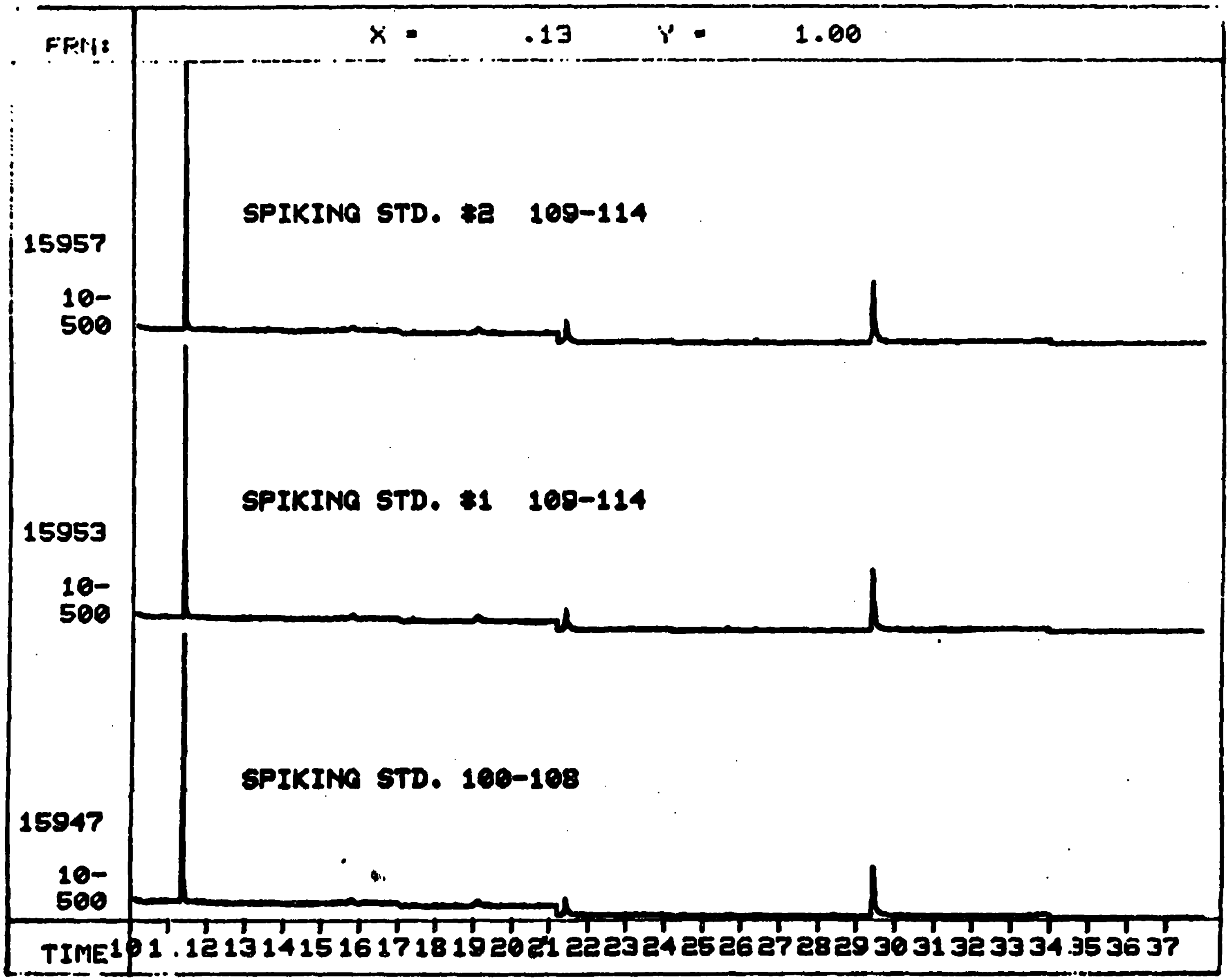
PNA Screen - Cost Element A-2

ERT Task: 220



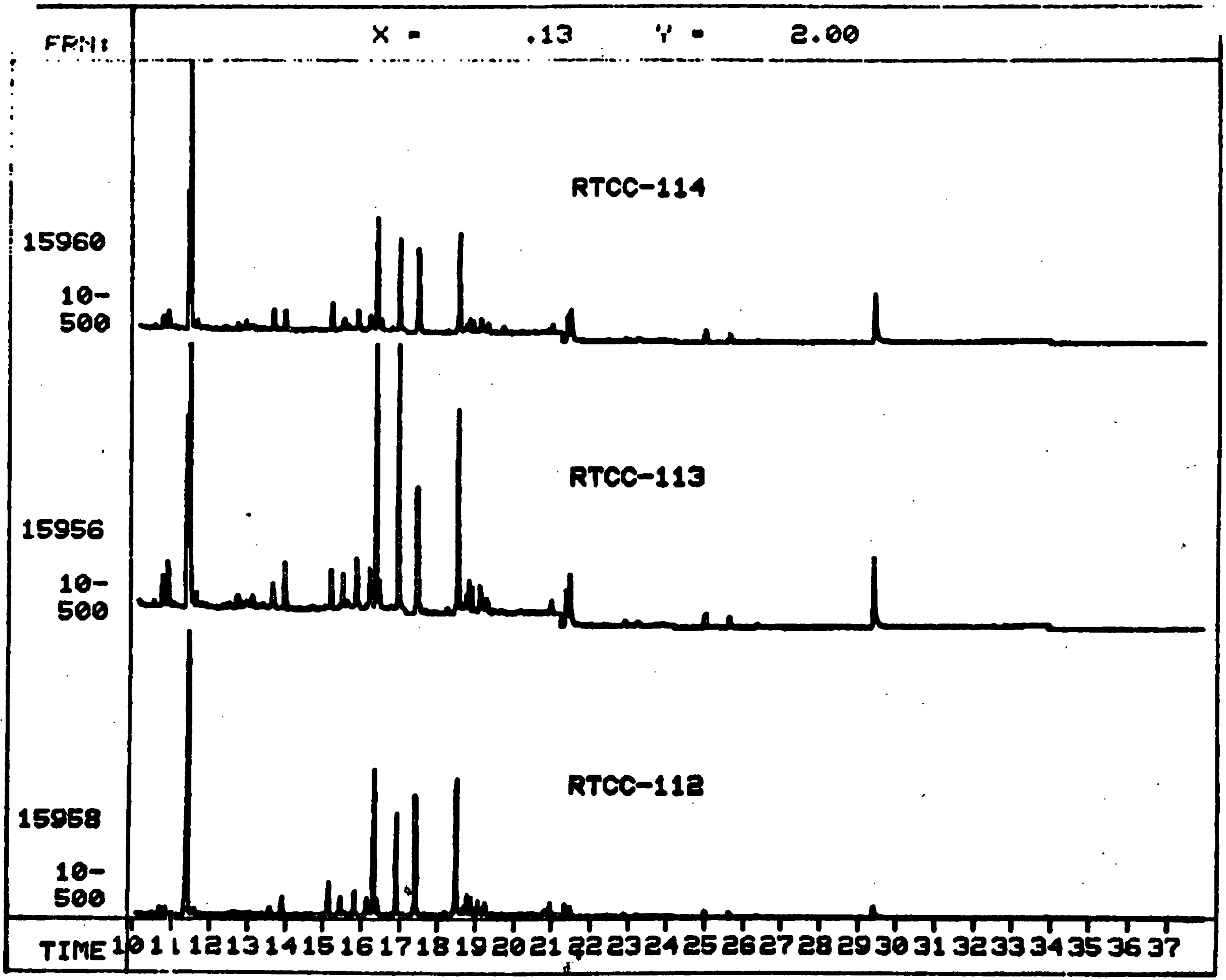
PNA Screen - QA/QC

100419



PNA Screen - QA/QC

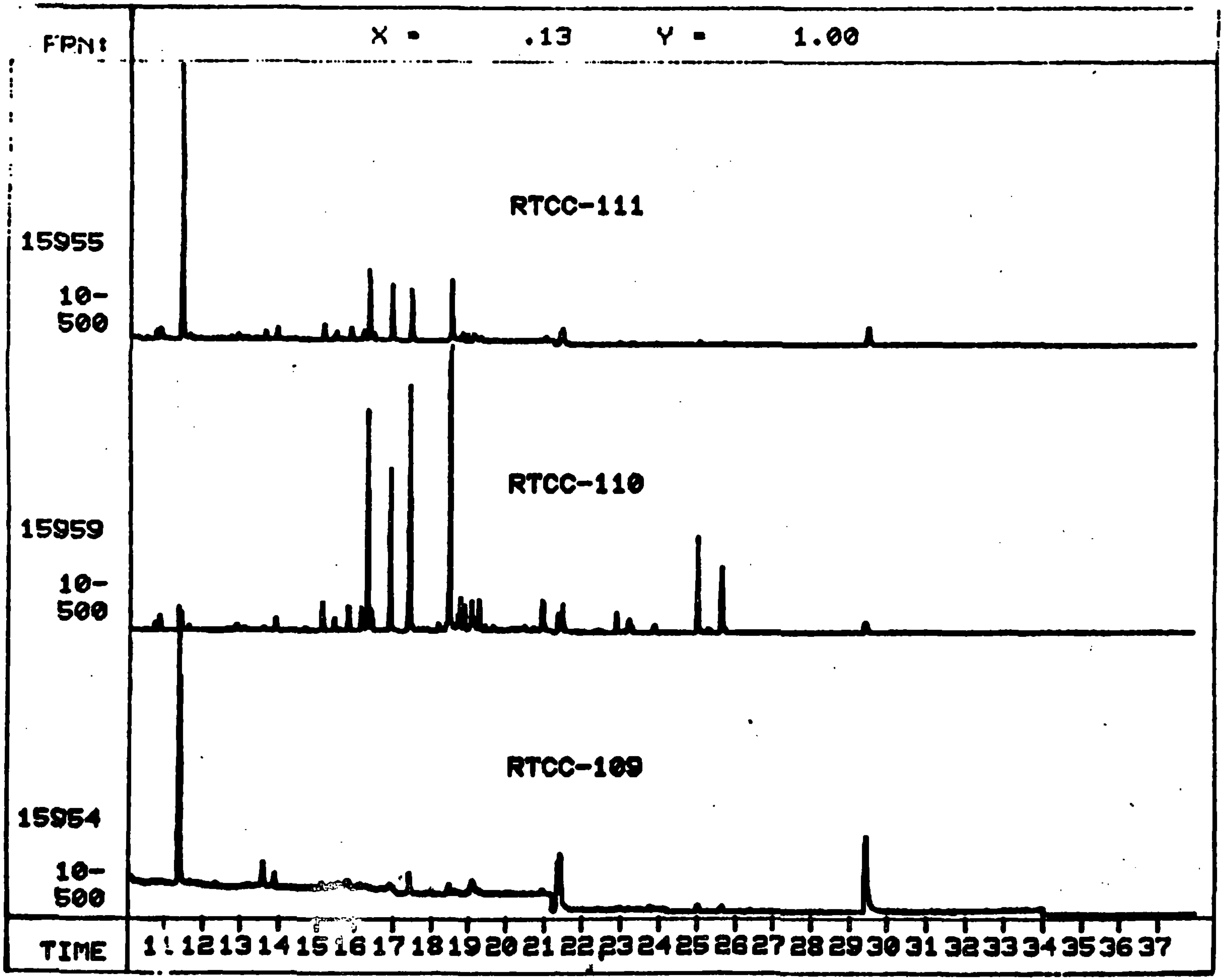
1064420



PNA Screen - Cost Element A-2

ERT Task: 210

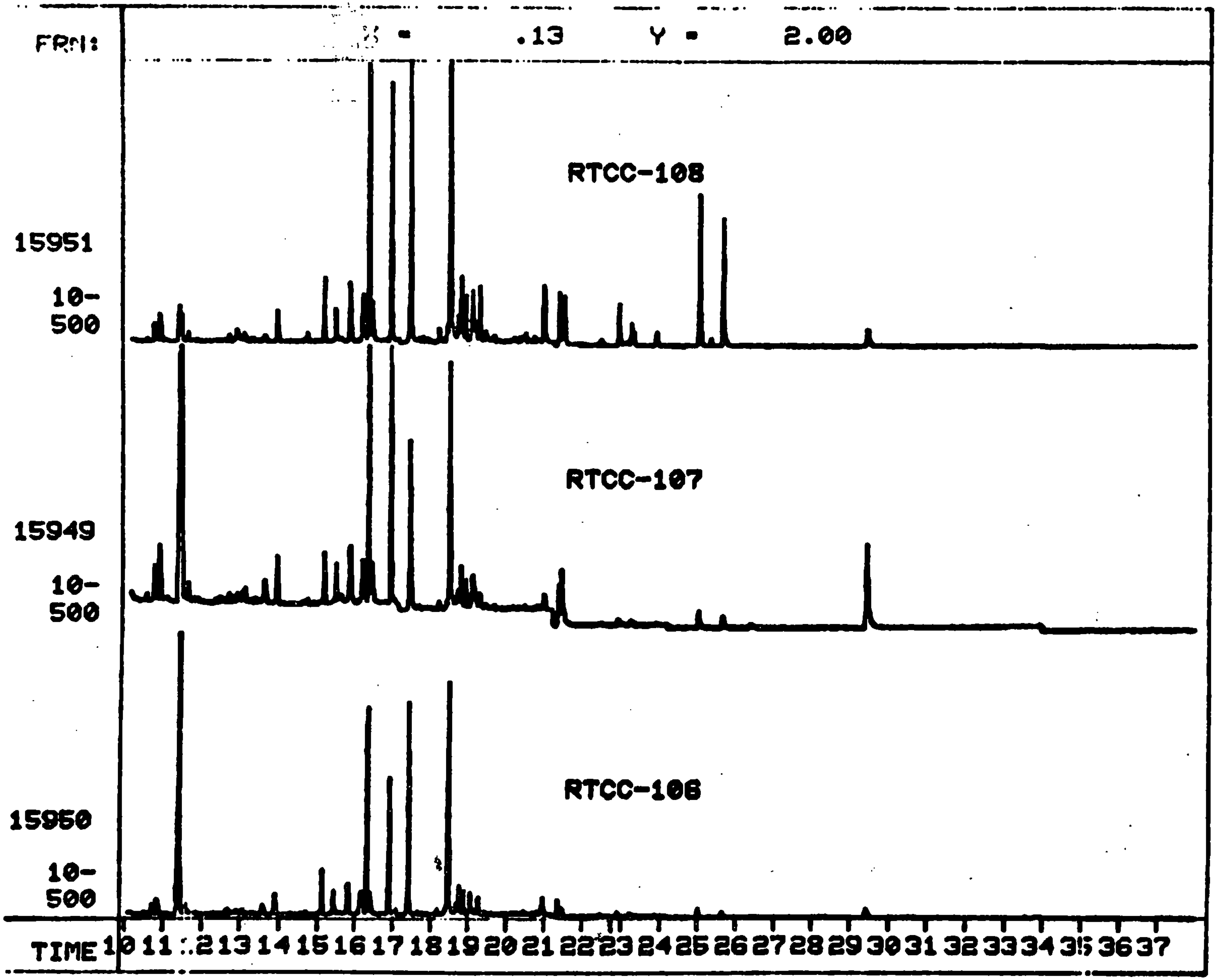
1054421



PNA Screen - Cost Element A-2

ERT Task: 210

1064422



PNA Screen - Cost Element A-2

ERT Task: 210

1054423

rec'd 10/ 83

TABLE 6. RESULTS OF SIM ANALYSES FOR PNAs FOR CH_2M HILL WATER SAMPLES

SLP #9

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Method Blank RTCC-120	~~Monitor Well~~ #9 RTCC-119	Monitor Well #70 RTCC-117	
					Concentration (ng/L)			
Naphthalene	1	1.3	11.42	128	38	90	34	
Methyl naphthalene (#1)	2	2.1	13.60	141	11	17	11	
" " (#2)	3	2.1	13.90	"	5.4	3.3	5.4	
Biphenyl	4	6.1	15.13	152	8.9	7.3	94	
Me_2-naphthalene (#1)	5			141				
" (#2)	6	3.4	15.43	"	4.6	6.9	59	
" (#3)	7	3.4	15.82	"	10	15	19	
" (#4)	8	3.4	16.17	"	8.2	5.3	4.3	
" (#5)	9	3.4	16.43	"	8.4	3.7	7.9	
" (#6)	10	3.4	16.93	"	4.0	4.1	9.0	
" (#7)	11	3.4		"				
Acenaphthalene	12	1.1	16.32	152	1.0	2.6	130	

TABLE 6 (continued)

SLP #9

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Method Blank RTCC-120	Sample Identification: Monitor Well #9 RTCC-119	Sample Identification: Monitor Well #70 RTCC-117	
					Concentration (ng/L)			
Dihydroacenaphthene	13	4.7	16.90	152	4.8	13	660	
Dibenzofuran	14	1.4	17.42	168	7.0	8.8	21	
Fluorene	15	2.2	18.48	166	3.7	9.1	380	
Me-dihydronaphthene (#1)	16	2.7	18.78	168	ND[b]	3.6	66	
" (#2)	17	2.7	18.88	"	ND	4.2	47	
Me-dibenzofuran (#1)	18	2.2	19.07	182	1.0	1.7	45	
" (#2)	19	2.2	19.27	"	1.5	2.3	79	
Phenanthrene	20	1.7	21.35	178	24	35	13	
Anthracene	22	1.7	21.48	"	ND	4.3	6.7	
Me-phenanthrene (#1)	23	2.6	22.90	192	0.51	1.7	52	
" (#2)	24	2.6	22.98	"	ND	ND	ND	
" (#3)	25	2.6	23.23	"	0.71	0.91	36	
" (#4)	26	2.6	23.30	"	ND	ND	ND	

HUGHES/FF-2

TABLE 6 (continued)

SLP #9

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Method Blank RTCC-120	~~Monitor Well~~ #9 RTCC-119	Monitor Well #70 RTCC-117
					Concentration (ng/L)		
Me-phenanthrene (#5)	27	2.6	23.30	192	ND	ND	ND
Phenyl naphthalene	28	2.5	23.90	204	1.3	2.0	21
MW = 188	29		23.18	188	ND	ND	1.2
Fluoranthene	31	2.0	25.02	202	4.7	16	24
Pyrene	32	2.0	25.65	"	4.4	15	180
Benzo(a)anthracene	33	5.3	29.38	228	ND	1.7	10
Chrysene	34	5.3	29.52	"	1.6	ND	ND
MW = 252 (#1)	36	6.8	32.50	252	ND	4.8	ND
" (#2)	37	6.8	32.80	"	ND	ND	ND
" (#3)	38	6.8	33.20	"	ND	0.6	ND
Benzo(a)pyrene	39	6.8	33.30	"	ND	ND	ND
MW = 252 (#4)-perylene	40	6.8	33.60	"	ND	ND	ND
MW = 228 (#1)-Benzo(c)-phenanthrene	41	5.3	28.8	228	ND	ND	3.7

1006426

TABLE 6 (continued)

scp #9

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Method Blank RTCC-120	~~Monitor Well~~ #9 RTCC-119	Monitor Well #70 RTCC-117	
					Concentration (ng/L)			
MW = 228 (#2)	42	5.3	29.73	228	ND	ND	ND	
MW = 202	43	4.1	25.32	202	ND	ND	2.7	
MW = 276 (#1)	44	10	35.90	276	ND	ND	ND	
Indeno(1,2,3,cd)pyrene	45	10	36.21	"	ND	ND	ND	
Benzo(g,h,i)perylene	46	10	36.82	"	ND	ND	ND	
MW = 276 (#2)	47	10	37.20	"	ND	ND	ND	
Dibenzothiophene	62	1.7	20.97	184	2.3	2.6	45	

TABLE 6 (continued) SLP #9

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Method Blank RTCC-120	~~Monitor Well~~ #9 RTCC-119	Monitor Well #70 RTCC-117	
					Concentration (ng/L)			
Anthracene-d_{10} (IS)	21	1.7	21.43	188	25	25	25	
Surrogate Spiking Compound		Amount added (ng/L)			Recovery (%)			
Naphthalene-d_8	63	100	11.42	136	42	55	42	
Chrysene-d_{12}	35	100	29.42	240	58	53	59	

[a] L.O.D. = limit of detection in ng/L.

[b] ND = none detected with a detection limit given by the L.O.D. value for each feature.

TABLE 7. RESULTS OF SIM ANALYSES FOR PNAs CH_2M HILL WATER SAMPLES

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Hopkins Well #3 RTCC-122	City Well #4 RTCC-115 (SLP 4)	Monitor Well #5 RTCC-121 (SLP 5)	City Well #7 RTCC-116 (SLP 7)
					Concentration (ng/L)			
Naphthalene	1	1.3	11.42	128	35	30	31	27
Methyl naphthalene (#1)	2	2.1	13.60	141	9.9	9.8	8.9	9.3
" " (#2)	3	2.1	13.90	"	4.7	14	5.4	2.0
Biphenyl	4	6.1	15.13	152	9.0	13	5.5	12
Me_2-naphthalene (#1)	5			141				
" (#2)	6	3.4	15.43	"	5.6	8.5	6.0	9.2
" (#3)	7	3.4	15.82	"	10	9.3	6.0	7.8
" (#4)	8	3.4	16.17	"	3.9	9.5	6.9	8.1
" (#5)	9	3.4	16.43	"	6.4	5.2	5.6	6.6
" (#6)	10	3.4	16.93	"	ND[b]	ND	4.0	ND
" (#7)	11	3.4		"				
Acenaphthalene	12	1.1	16.32	152	1.8	4.6	12	11

106430

TABLE 7 (continued)

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Hopkins Well #3 RTCC-122 (SLP 3?)	City Well #4 RTCC-115 (SLP 4)	Monitor Well #5 RTCC-121 (SLP 5)	City Well #7 RTCC-116 (SLP 7)
					Concentration (ng/L)			
Dihydroacenaphthene	13	4.7	16.90	152	5.6	94	ND	26
Dibenzofuran	14	1.4	17.42	168	7.2	ND	1.2	9.5
Fluorene	15	2.2	18.48	166	3.5	13	6.8	10
Me-dihydronaphthene (#1)	16	2.7	18.78	168	ND	ND	ND	4.3
" (#2)	17	2.7	18.88	"	ND	6.9	ND	5.0
Me-dibenzofuran (#1)	18	2.2	19.07	182	1.3	3.1	9.0	1.9
" (#2)	19	2.2	19.27	"	1.6	2.3	ND	2.9
Phenanthrene	20	1.7	21.35	178	9.3	29	6.8	11
Anthracene	22	1.7	21.48	"	0.61	1.0	14	1.2
Me-phenanthrene (#1)	23	2.6	22.90	192	0.46	2.5	ND	2.9
" (#2)	24	2.6	22.98	"	ND	ND	ND	ND
" (#3)	25	2.6	23.23	"	ND	2.9	2.0	2.5
" (#4)	26	2.6	23.30	"	1.8	ND	ND	ND

TABLE 7 (continued)

SZP 4 SZP 5 SZP 7

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Hopkins Well #3 RTCC-122	City Well #4 RTCC-115	Monitor Well #5 RTCC-121	City Well #7 RTCC-116
					Concentration (ng/L)			
Me-phenanthrene (#5)	27	2.6	23.30	192	ND	ND	ND	ND
Phenyl naphthalene	28	2.5	23.90	204	0.89	1.1	ND	2.0
MW = 188	29		23.18	188	ND	ND	ND	ND
Fluoranthene	31	2.0	25.02	202	5.4	7.1	1.5	3.6
Pyrene	32	2.0	25.65	"	6.6	6.9	3.1	7.8
Benzo(a)anthracene	33	5.3	29.38	228	ND	0.63	ND	ND
Chrysene	34	5.3	29.52	"	2.3	1.4	3.4	2.7
MW = 252 (#1)	36	6.8	32.50	252	ND	2.1	ND	ND
" (#2)	37	6.8	32.80	"	ND	ND	ND	ND
" (#3)	38	6.8	33.20	"	ND	ND	ND	ND
Benzo(a)pyrene	39	6.8	33.30	"	ND	ND	ND	ND
MW = 252 (#4)-perylene	40	6.8	33.60	"	ND	ND	ND	ND
MW = 228 (#1)-Benzo(c)-phenanthrene	41	5.3	28.8	228	ND	ND	ND	ND

TABLE 7 (continued)

SLP 4 SLP 5 SLP 7

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification			
					Hopkins Well #3 RTCC-122	City Well #4 RTCC-115	Monitor Well #5 RTCC-121	City Well #7 RTCC-116
					Concentration (ng/L)			
MW = 228 (#2)	42	5.3	29.73	228	ND	ND	ND	ND
MW = 202	43	4.1	25.32	202	ND	ND	ND	ND
MW = 276 (#1)	44	10	35.90	276	ND	ND	ND	ND
Indeno(1,2,3,cd)pyrene	45	10	36.21	"	ND	ND	ND	ND
Benzo(g,h,i)perylene	46	10	36.82	"	ND	ND	ND	ND
MW = 276 (#2)	47	10	37.20	"	ND	ND	ND	ND
Dibenzothiophene	62	1.7	20.97	184	1.9	2.1	13	2.6

TABLE 7 (continued)

SZP 4 SZP 5 SZP 7

Feature Identification	Feature Number	Feature L.O.D.[a]	Feature RT (min)	Feature Mass	Sample Identification: Hopkins Well #3 RTCC-122	City Well #4 RTCC-115	Monitor Well #5 RTCC-121	City Well #7 RTCC-116
					Concentration (ng/L)			
Anthracene-d_{10} (IS)	21	1.7	21.43	188				
Surrogate Spiking Compound		Amount added (ng/L)			Recovery (%)			
Naphthalene-d_8	63	100	11.42	136	50	44	39	49
Chrysene-d_{12}	35	100	29.42	240	57	82	53	63

[a]L.O.D. = limit of detection in ng/L.

[b]ND = none detected with a detection limit given by the L.O.D. value for each feature.

10/22/82
N.

MONSANTO RESEARCH CORPORATION   *Inter-Office Correspondence*

FROM LOCATION : B. M. Hughes, Dayton Laboratory

DATE : 22 October 1982

SUBJECT : Reilly Tar and Chemical Corp. Project

REFERENCE :

CC: John Craun (ERT)
Bill Roder (RTCC)
Files (MRC-Hughes)

RECEIVED

OCT 25 1982

ERT

TO : Gary Wilson
ERT
696 Virginia Road
Concord, Mass 01742

Incl 1) 9/82 SLP15 test
2) W23 samples
3) SLP 4, 5, 7, 9; H3; MW13 & 70 ← in this file

Enclosed are PNA and wide-scan screening chromatograms for RTCC extraction numbers 106-129. In addition, I have enclosed a summary of documents which are contained in MRC's Reilly Tar and Chemical Corp. files. I will be sending you other deliverables as they become available, along with a set of MRC analytical request sheets for this project.

B. M. Hughes

B. M. Hughes

BMH/cvd

Encs.

106316

RC-10

rec'd 10/14/82

1. SUMMARY OF REILLY TAR & CHEMICAL "ROUTINE" EXTRACTIONS AND ANALYSES

SAMPLE IDENTIFICATION	RTCC EXTRACTION NUMBER	COST ELEMENT[a]/BILLING MONTH[b]						
		A-1[c] Extraction	A-2 PNA Screen	A-3 Wide Scan Screen	B-1 Coal Tar Quant.	B-2 PNA Quant.	A-3 VOA Screen	B-3, B-4 Detailed MS Interpret
CW #15 (After chlorination)	106	1 (Sept)	1(Sept)	1(Sept)	1(Sept)	1(Sept)		
CW #15 (After chlorination and filtration)	107	1	1	1	1	1		
CW #15 (At well head)	108	1	1	1	1	1		
Method Blank	109	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #15 (At well head)	110	1	1	1	1	1		
CW #15 (After well head and aeration)	111	1	1	1	1	1		
CW #15 (After chlorination)	112	1	1	1	1	1		
CW #15(After chlorination and filtration)	113	1	1	1	1	1		
CW #15 (After well head and aeration)	114	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #4	115	1	1	1	1	1		
CW #7	116	1	1	1	1	1		
MW #70	117	1	1	1	1	1		
MW #13	118	1	1	1	1	1		
CW #9	119	1	1	1	1	1		

[a] Number of cost element indicates the number of samples or fractions being billed in each category. N.C. indicates no charge for this unit (A certain number of Quality Control Samples are indicated).

[b] Billing month indicates the actual month in which charges for the fraction/cost unit are made.

[c] Key for cost unit charges (refer to 22 September 1982 letter and estimates to John Craun for full explanations).
A-1 = $210/sample; A-2 = $150/sample; A-3 = $150/sample; B-1 = $200/sample; B-2 = $200/sample; B-3, B-4 = $600/sample

I. **SUMMARY OF REILLY TAR & CHEMICAL "ROUTINE" EXTRACTIONS AND ANALYSES**

SAMPLE IDENTIFICATION	RTCC EXTRACTION NUMBER	COST ELEMENT[a]/BILLING MONTH[b]						
		A-1[c] Extraction	A-2 PNA Screen	A-3 Wide Scan Screen	B-1 Coal Tar Quant.	B-2 PNA Quant.	A-3 VOA Screen	B-3, B-4 Detailed MS Interpret
Method Blank	120	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #5	121	1	1	1	1	1		
Hopkins Well #3	122	1	1	1	1	1		
Deionized Water Spiked with Coal Tar	123	1	1	1	1	1		
Well #23 9/14/82 15:00	124	1	1	1	1	1		
Well #23 9/17/82 16:30	125	1	1	1	1	1		
Well #23 9/17/82 16:30	126	1	1	1	1	1		
Method Blank	127	N.C	N.C	N.C	N.C	N.C		
Well #23 7/29/82 861'	128	1	1	1	1	1		
Well #23 8/7/82 804.5'	129	1	1	1	1	1		

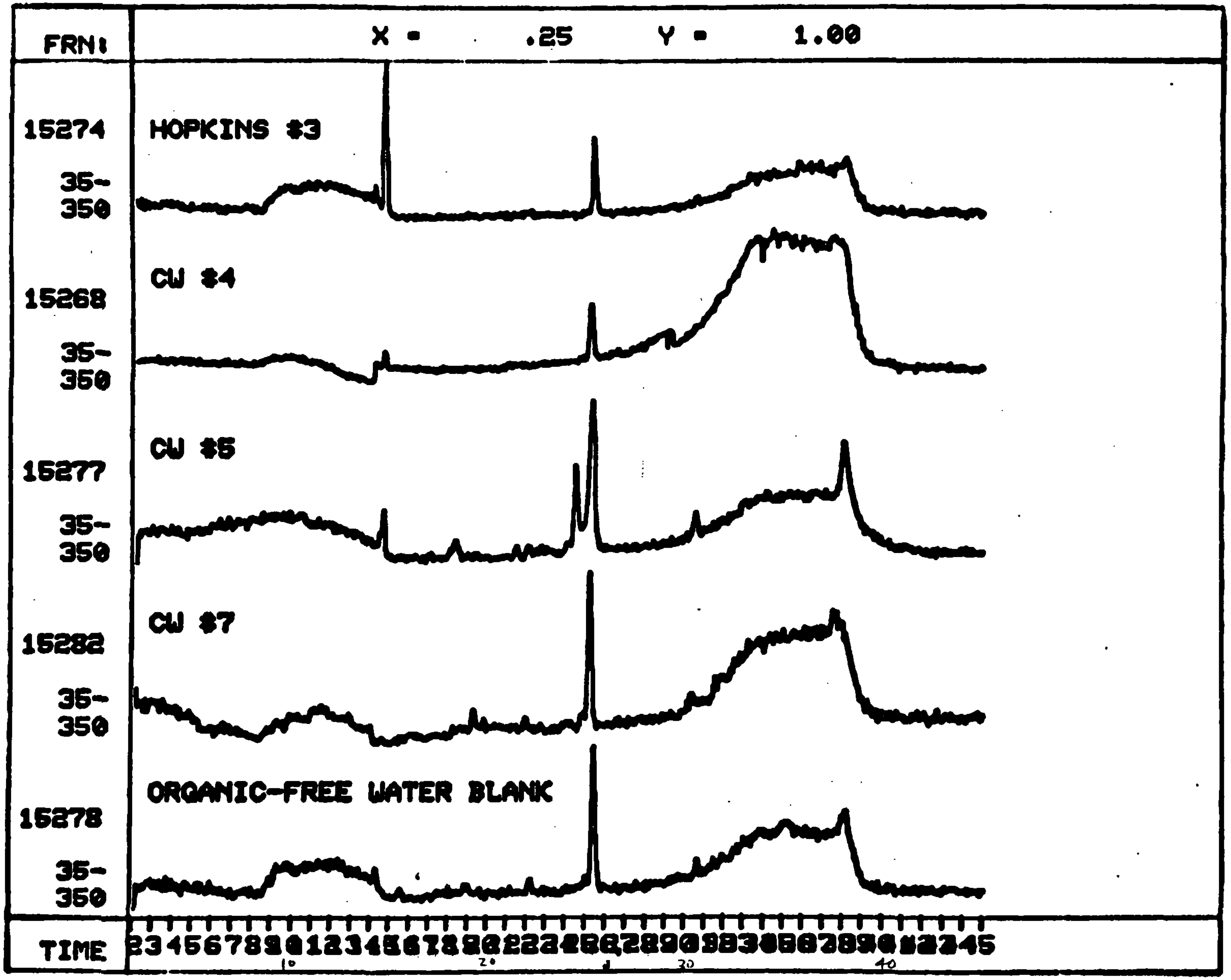
1063318

[a] Number of cost element indicates the number of samples or fractions being billed in each category. N.C. indicates no charge for this unit (A certain number of Quality Control Samples are indicated).

[b] Billing th indicates the actual month in which charges for the fraction/cost unit are made.

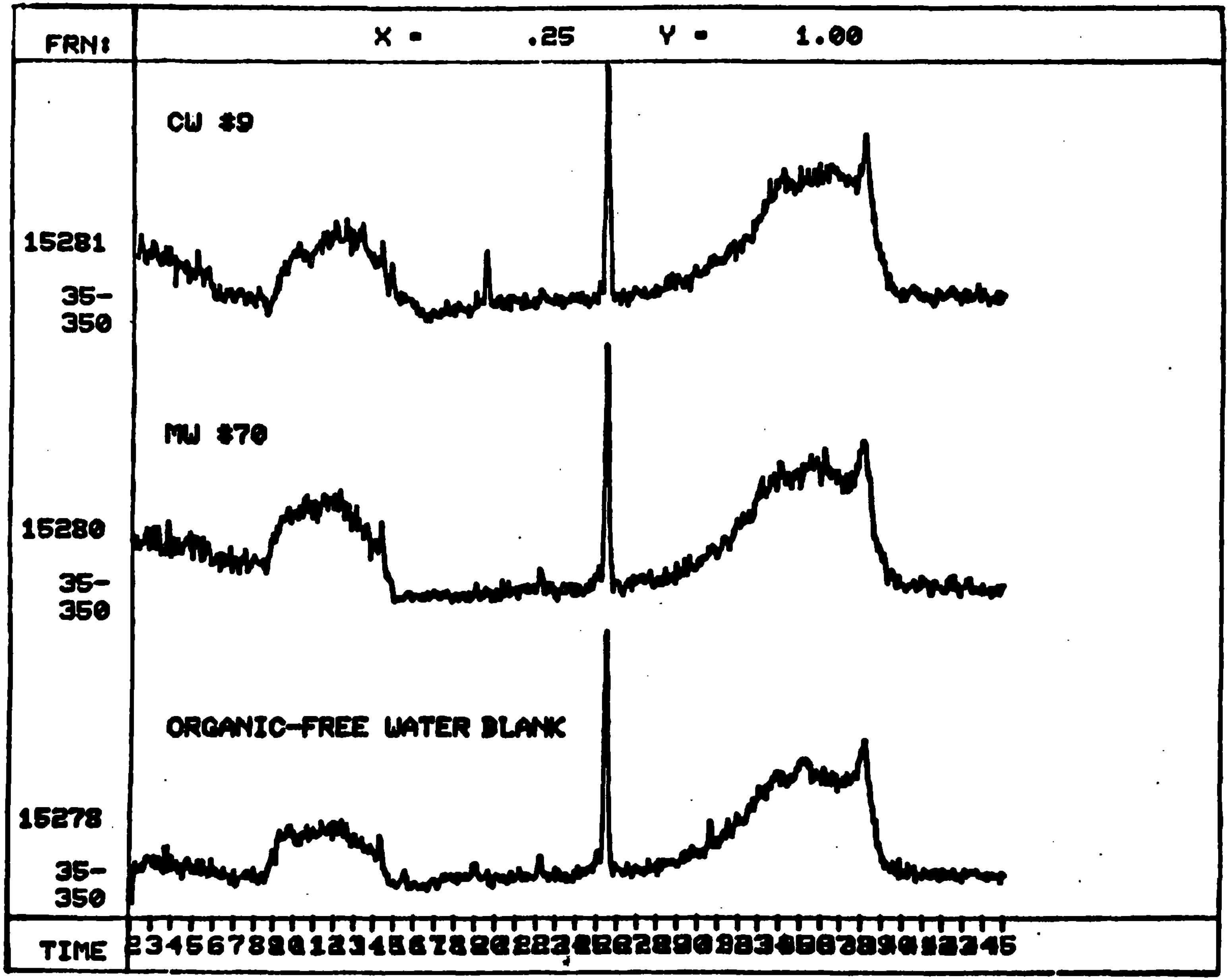
[c] Key for cost unit charges (refer to 22 September 1982 letter and estimates to John Craun for full explanations).

[illegible]



Volatile Wide Scan Screen - Cost Element A-3

ERT Task: 120



Volatile Wide Scan Screen - Cost Element A-3

ERT Task: 120

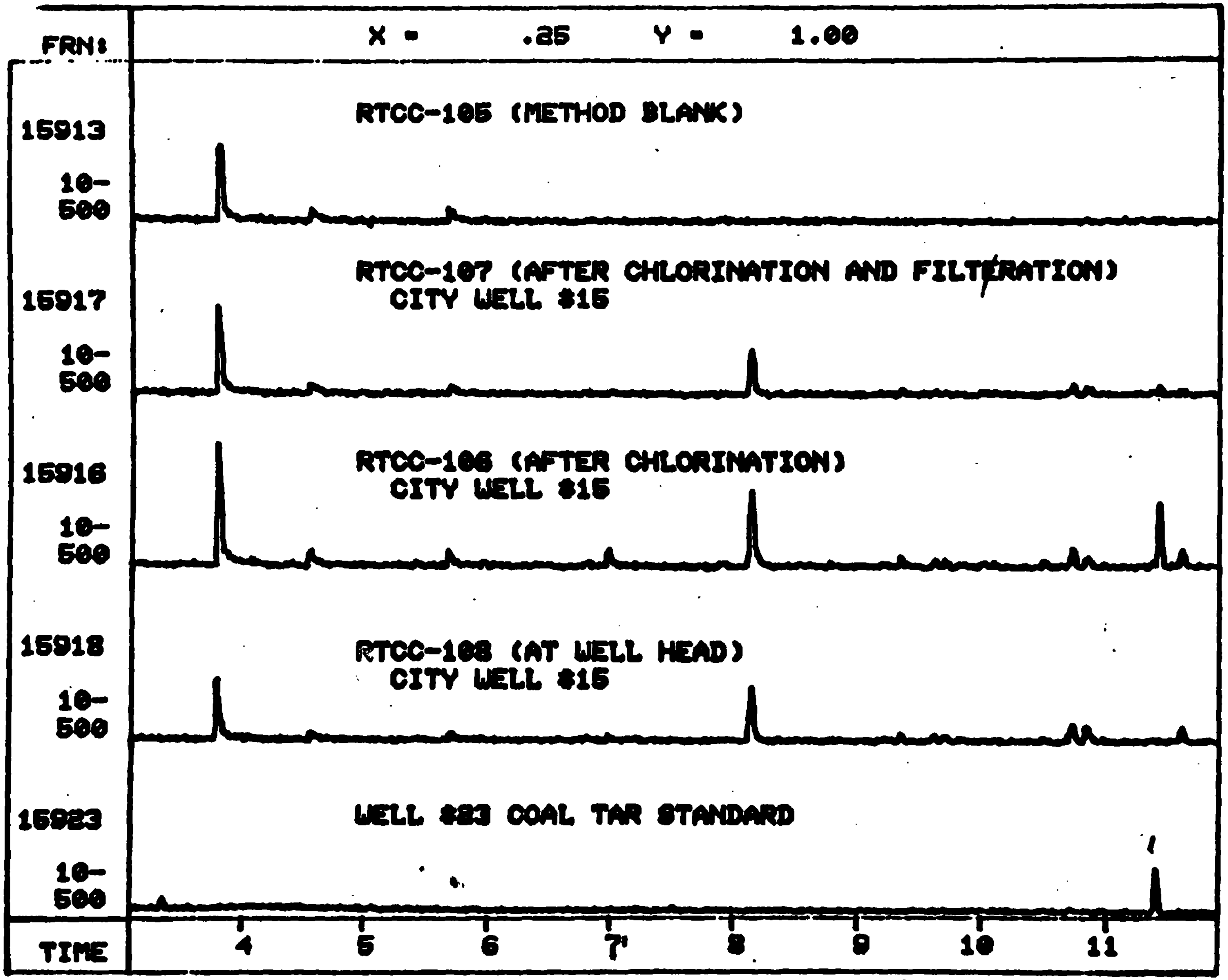


Figure 3. Comparison of selected screening chromatograms for RTCC Study. Full scale response for each chromatogram corresponds to 2.5 µg/L anthracene-d10.

MONSANTO RESEARCH CORPORATION **Inter-Office Correspondence**

From LOCATION : B. M. Hughes, Dayton Laboratory

DATE : 22 October 1982

SUBJECT : Reilly Tar and Chemical Corp. Project

REFERENCE :

cc: John Craun (ERT)
Bill Roder (RTCC)
Files (MRC-Hughes)

RECEIVED

OCT 25 1982

ERT

TO : Gary Wilson
ERT
696 Virginia Road
Concord, Mass 01742

Incl 1) 9/82 SP15 test
2) W23 samples
3) SP 4,5,7,9; H3; MW13 170 ← In this file

Enclosed are PNA and wide-scan screening chromatograms for RTCC extraction numbers 106-129. In addition, I have enclosed a summary of documents which are contained in MRC's Reilly Tar and Chemical Corp. files. I will be sending you other deliverables as they become available, along with a set of MRC analytical request sheets for this project.

B. M. Hughes

B. M. Hughes

BMH/cvd

Encs.

106352

RC-10

rec'd 10/14/82

I. SUMMARY OF REILLY TAR & CHEMICAL "ROUTINE" EXTRACTIONS AND ANALYSES

SAMPLE IDENTIFICATION	RTCC EXTRACTION NUMBER	COST ELEMENT[a]/BILLING MONTH[b]						
		A-1[c] Extraction	A-2 PNA Screen	A-3 Wide Scan Screen	B-1 Coal Tar Quant.	B-2 PNA Quant.	A-3 VOA Screen	B-3, B-4 Detailed MS Interpret
CW #15 (After chlorination)	106	1 (Sept)	1(Sept)	1(Sept)	1(Sept)	1(Sept)		
CW #15 (After chlorination and filtration)	107	1	1	1	1	1		
CW #15 (At well head)	108	1	1	1	1	1		
Method Blank	109	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #15 (At well head)	110	1	1	1	1	1		
CW #15 (After well head and aeration)	111	1	1	1	1	1		
CW #15 (After chlorination)	112	1	1	1	1	1		
CW #15(After chlorination and filtration)	113	1	1	1	1	1		
CW #15 (After well head and aeration)	114	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #4	115	1	1	1	1	1		
CW #7	116	1	1	1	1	1		
MW #70	117	1	1	1	1	1		
MW #13	118	1	1	1	1	1		
CW #9	119[d]	1	1	1	1	1		

[a] Number of cost element indicates the number of samples or fractions being billed in each category. N.C. indicates no charge for this unit (A certain number of Quality Control Samples are indicated).

[b] Billing month indicates the actual month in which charges for the fraction/cost unit are made.

[c] Key for cost unit charges (refer to 22 September 1982 letter and estimates to John Craun for full explanations).
A-1 = $210/sample; A-2 = $159/sample; A-3 = $159/sample; B-1 = $200/sample; B-2 = $200/sample; B-3, B-4 = $600/sample

1.

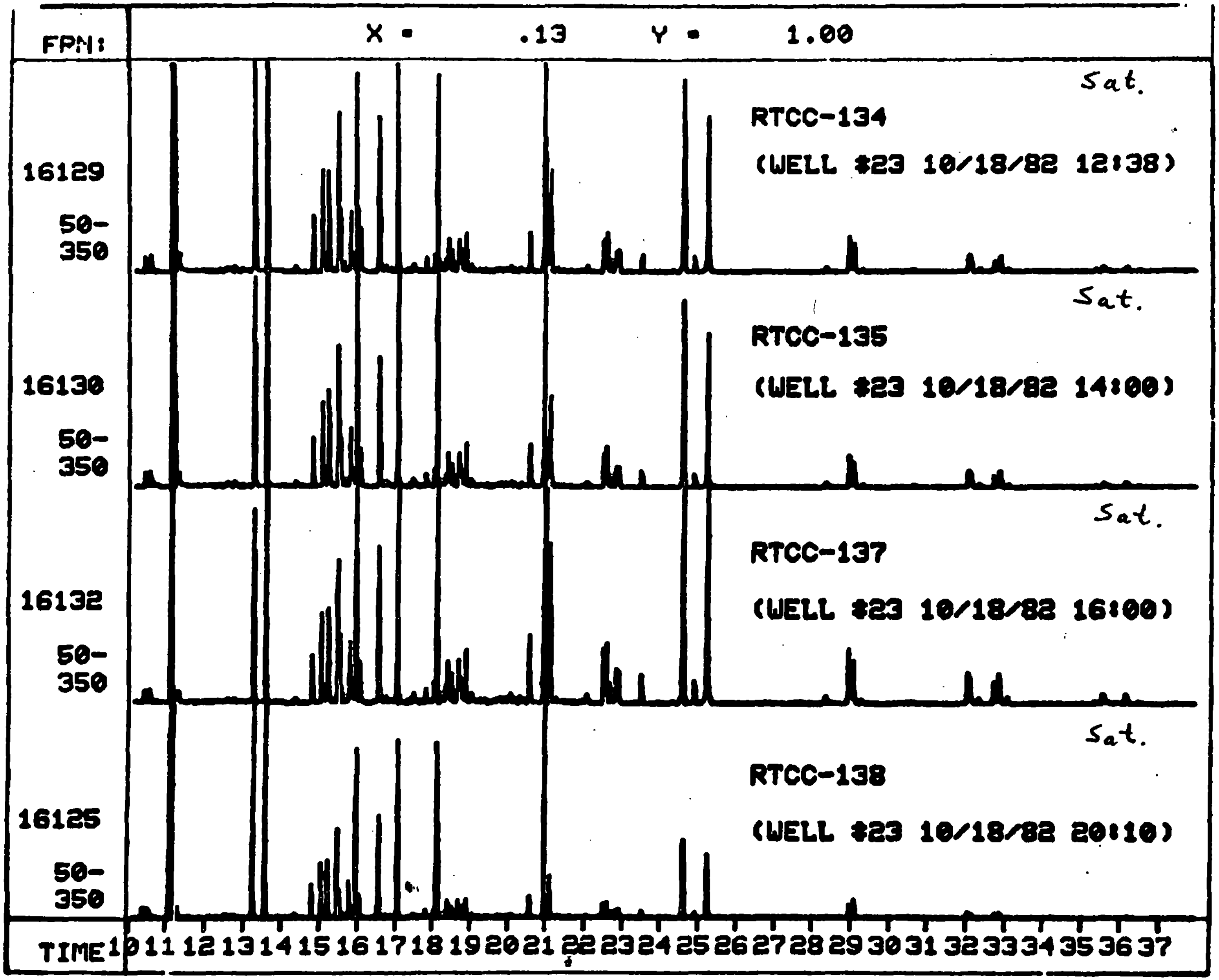
SUMMARY OF REILLY TAR & CHEMICAL "ROUTINE" EXTRACTIONS AND ANALYSES

SAMPLE IDENTIFICATION	RTCC EXTRACTION NUMBER	COST ELEMENT[a]/BILLING MONTH[b]						
		A-1[c] Extraction	A-2 PNA Screen	A-3 Wide Scan Screen	B-1 Coal Tar Quant.	B-2 PNA Quant.	A-3 VOA Screen	B-3, B-4 Detailed MS Interpret
Method Blank	120	N.C.	N.C.	N.C.	N.C.	N.C.		
CW #5	121	1	1	1	1	1		
Hopkins Well #3	122	1	1	1	1	1		
Deionized Water Spiked with Coal Tar	123	1	1	1	1	1		
[illegible] 9/14/82 15:00	124	1	1	1	1	1		
Well #23 9/17/82 16:30	125	1	1	1	1	1		
Well #23 9/17/82 16:30	126	1	1	1	1	1		
Method Blank	127	N.C	N.C	N.C	N.C	N.C		
Well #23 7/29/82 861'	128	1	1	1	1	1		
Well #23 8/7/82 804.5'	129	1	1	1	1	1		

[a] Number of cost element indicates the number of samples or fractions being billed in each category. N.C. indicates no charge for this unit (A certain number of Quality Control [illegible] les are indicated).

[b] Billing [illegible] th indicates the actual month in which charges for the fraction/cost unit are made.

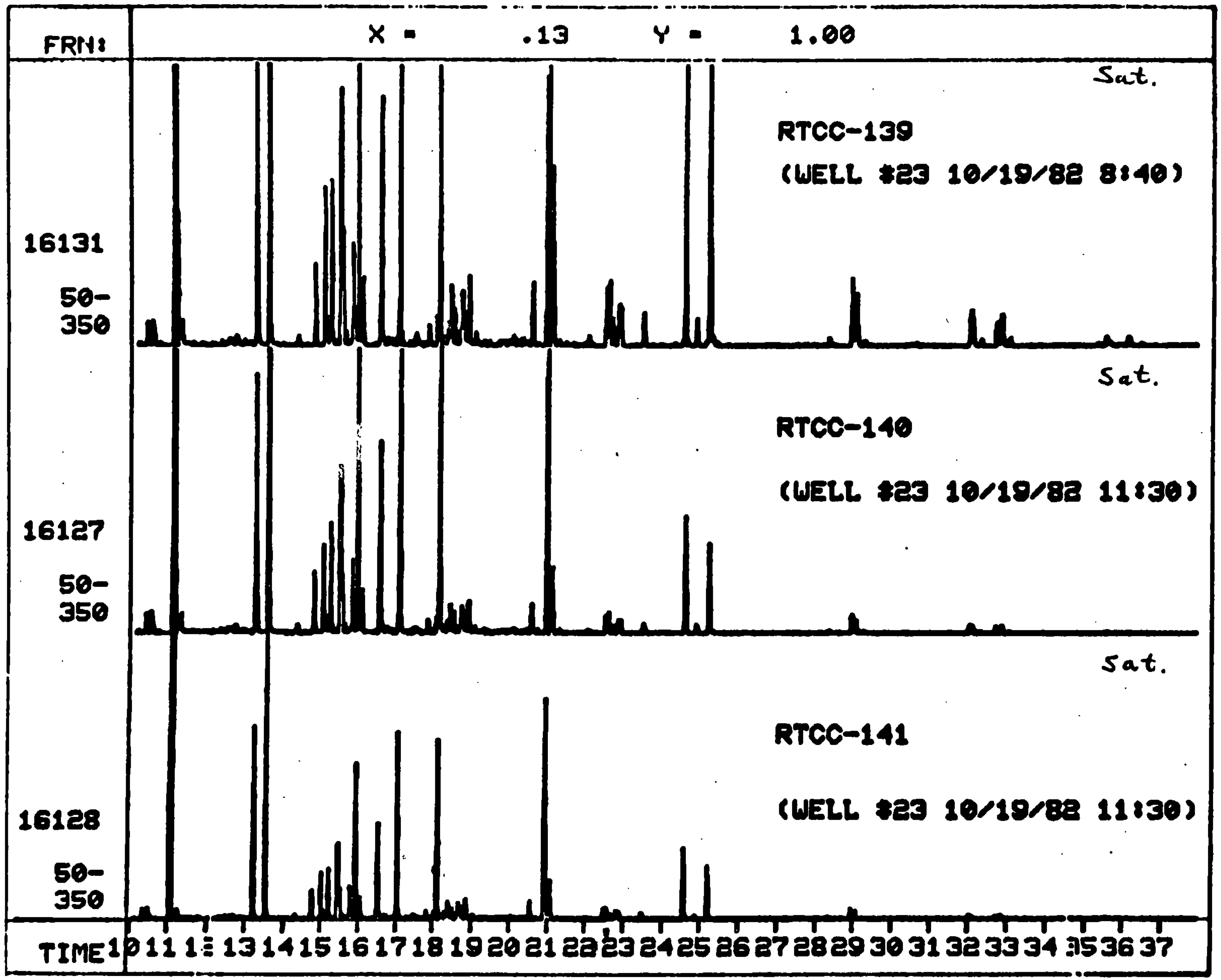
[c] Key for cost unit charges (refer to 22 September 1982 letter and estimates to John Craun for full explanations).



PNA Screen - Cost Element A-2

ERT Task: 220

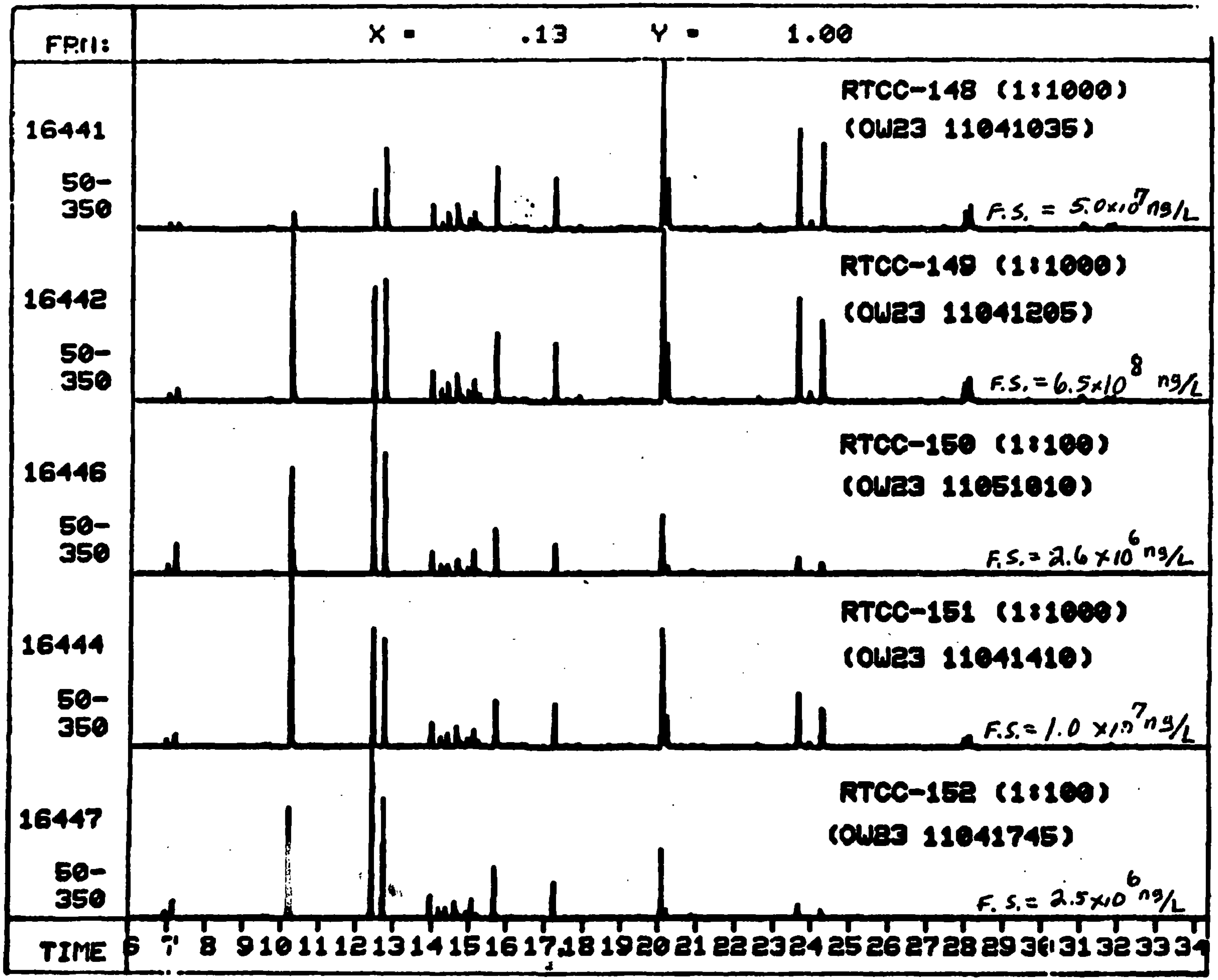
106355



PNA Screen - Cost Element A-2

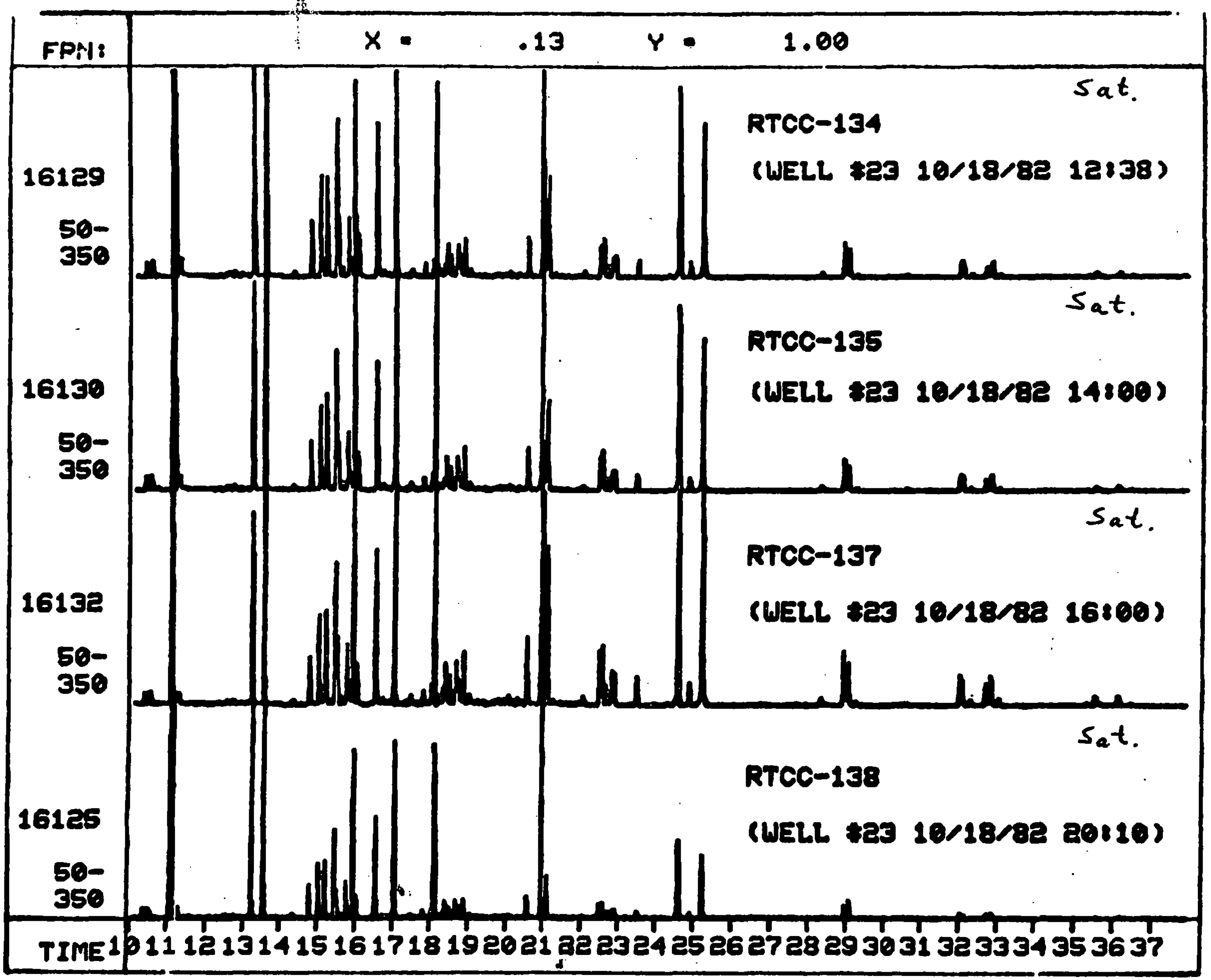
ERT Task: 220

106356



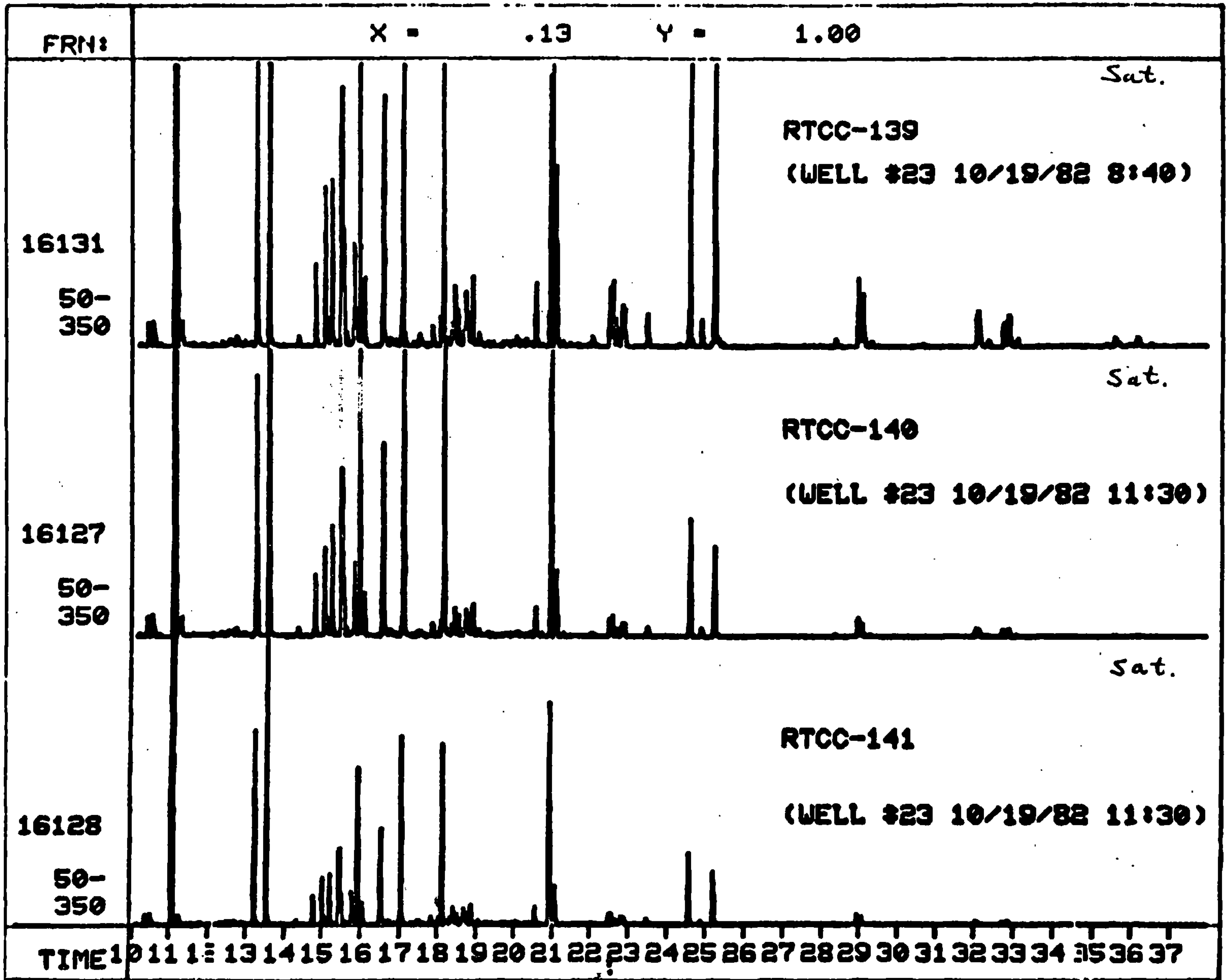
PNA Screen - Cost Element A-2

ERT Task: 220



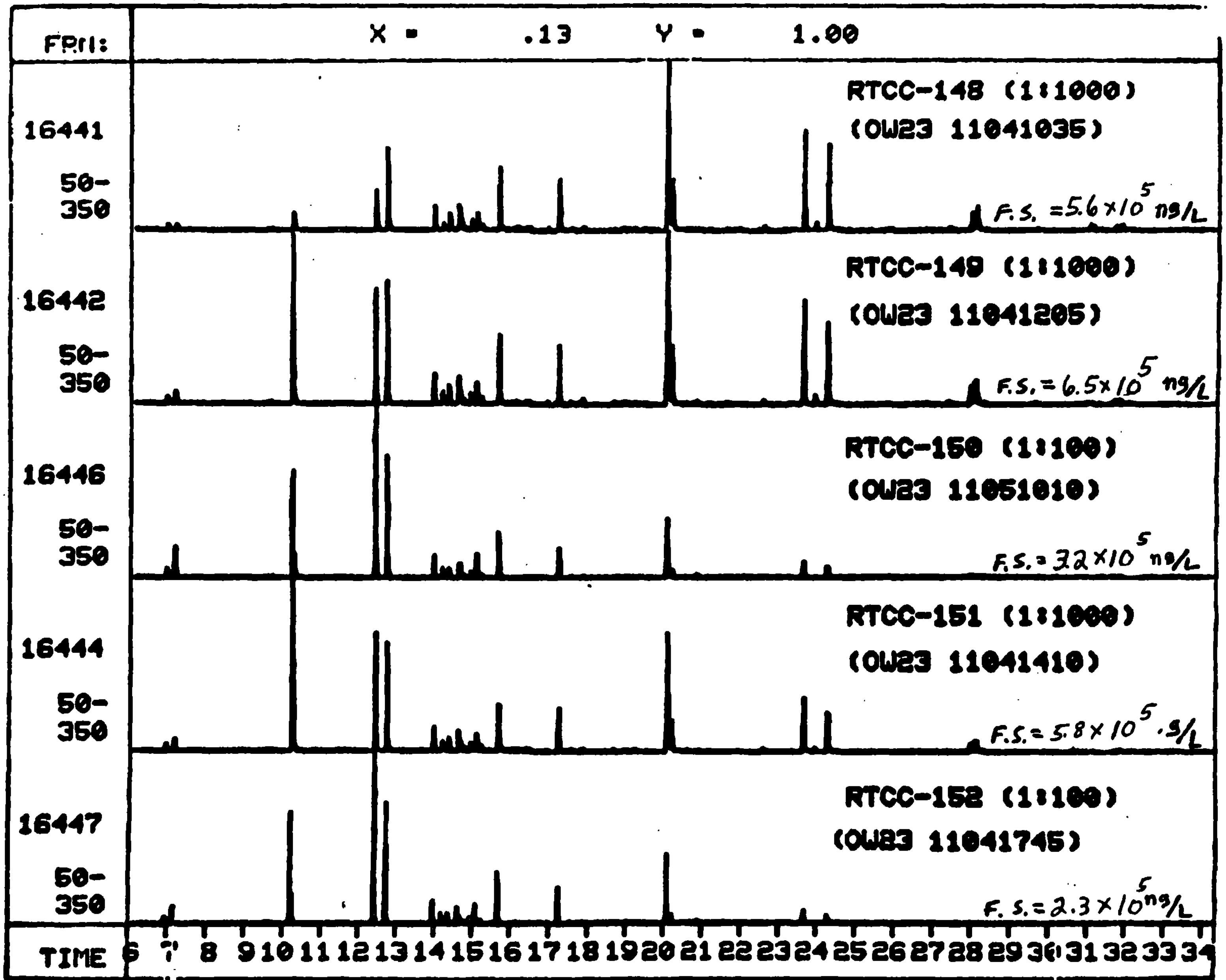
PNA Screen - Cost Element A-2

ERT Task: 220



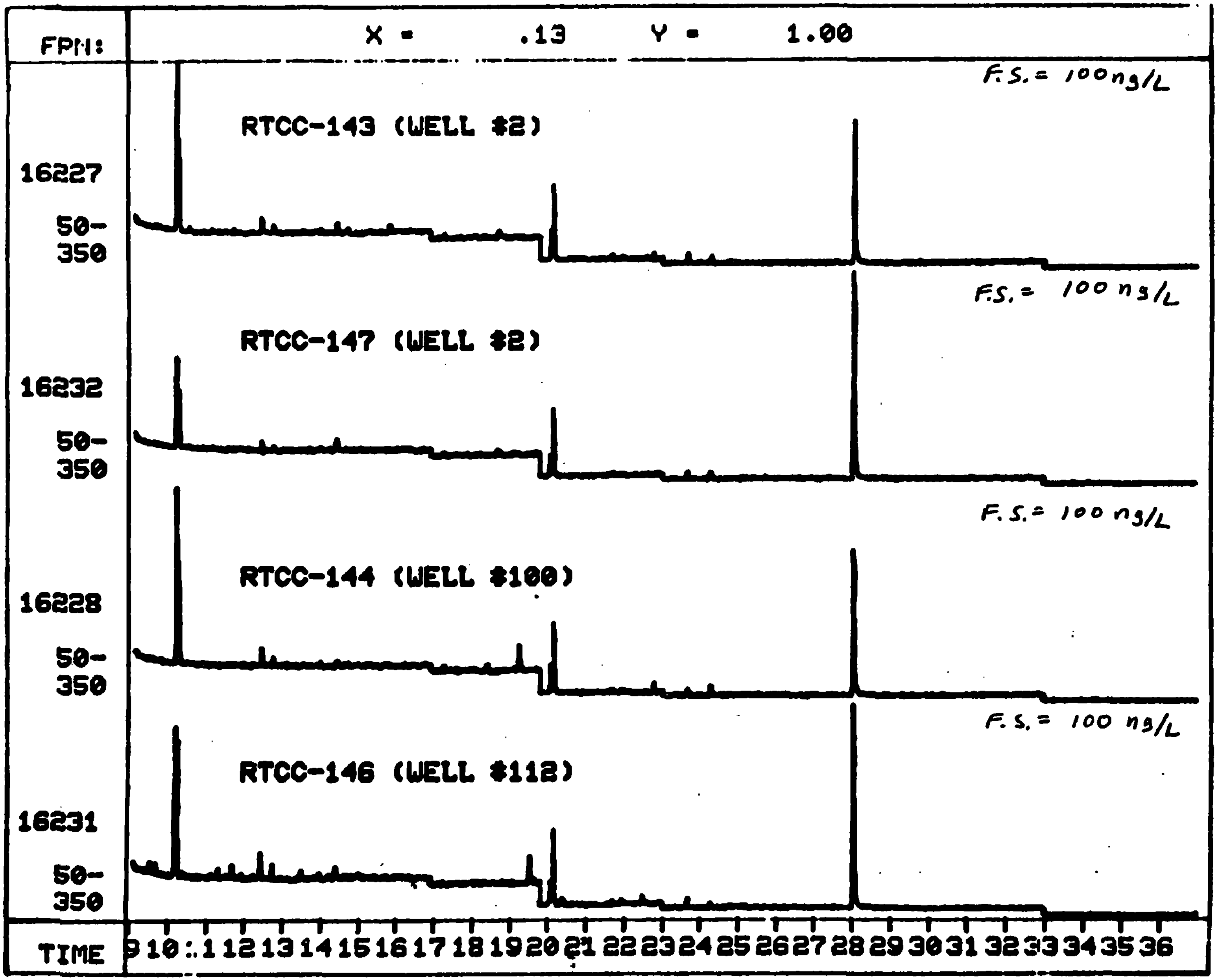
PNA Screen - Cost Element A-2

ERT Task: 220



PNA Screen - Cost Element A-2

ERT Task: 220



PNA Screen - Cost Element A-2

ERT Task: 120

TABLE 30. RESULTS OF SIM ANALYSES FOR PNAs FOR THE NOVEMBER 1982 OW #23 TREATMENT SYSTEM STUDY

Date: January 21, 1983 ERT Task: 220

Feature Identification (Q. Mass)	Feature Number	Feature L.O.D.[a]	Sample Identification 148 (dil 1:1000)	149 (dil 1:1000)	150 (dil 1:100)	151 (dil 1:1000)	152 (dil 1:100)
			Concentration (ng/L)				
Indene (116)	64	$3.2x10^2$	3.8×10^4	6.1×10^4	1.4×10^5	6.7×10^4	6.0×10^4
2,3-Dihydroindene (118)	65	$4.5x10^2$	2.3×10^4	4.2×10^4	4.7×10^4	4.4×10^4	2.6×10^4
Naphthalene (128)	1	200	6.0×10^4	4.6×10^5	8.5×10^5	5.8×10^5	4.7×10^5
2-Methylnaphthalene (141)	2	$3.6x10^2$	7.5×10^4	3.0×10^5	3.2×10^5	3.4×10^5	2.3×10^5
1-Methylnaphthalene (141)	3	$3.7x10^2$	1.7×10^5	2.7×10^5	1.8×10^5	2.6×10^5	1.4×10^5
Biphenyl (154)	4	$2.5x10^2$	4.7×10^4	9.0×10^4	5.4×10^4	7.5×10^4	4.3×10^5
C_2-naphthalene (141) - Total	5-11	$3.7x10^2$	2.0×10^4	2.7×10^5	9.5×10^4	1.9×10^5	8.7×10^4
Acenaphthylene (152)	12	$1.1x10^3$	3.6×10^4	6.5×10^4	4.3×10^4	1.2×10^5	3.0×10^4
Dihydroacenaphthylene (154)	13	50	1.2×10^5	2.0×10^5	1.0×10^5	2.0×10^5	9.3×10^4
Fluorene (166)	15	300	2.4×10^5	2.2×10^5	1.2×10^5	2.5×10^5	1.1×10^5
Phenanthrene (178)	20	300	5.6×10^5	6.5×10^5	1.6×10^5	4.4×10^5	1.3×10^5
Anthracene (178)	22	300	2.4×10^5	2.3×10^5	2.9×10^4	1.7×10^5	2.5×10^4

TABLE 30 (continued)

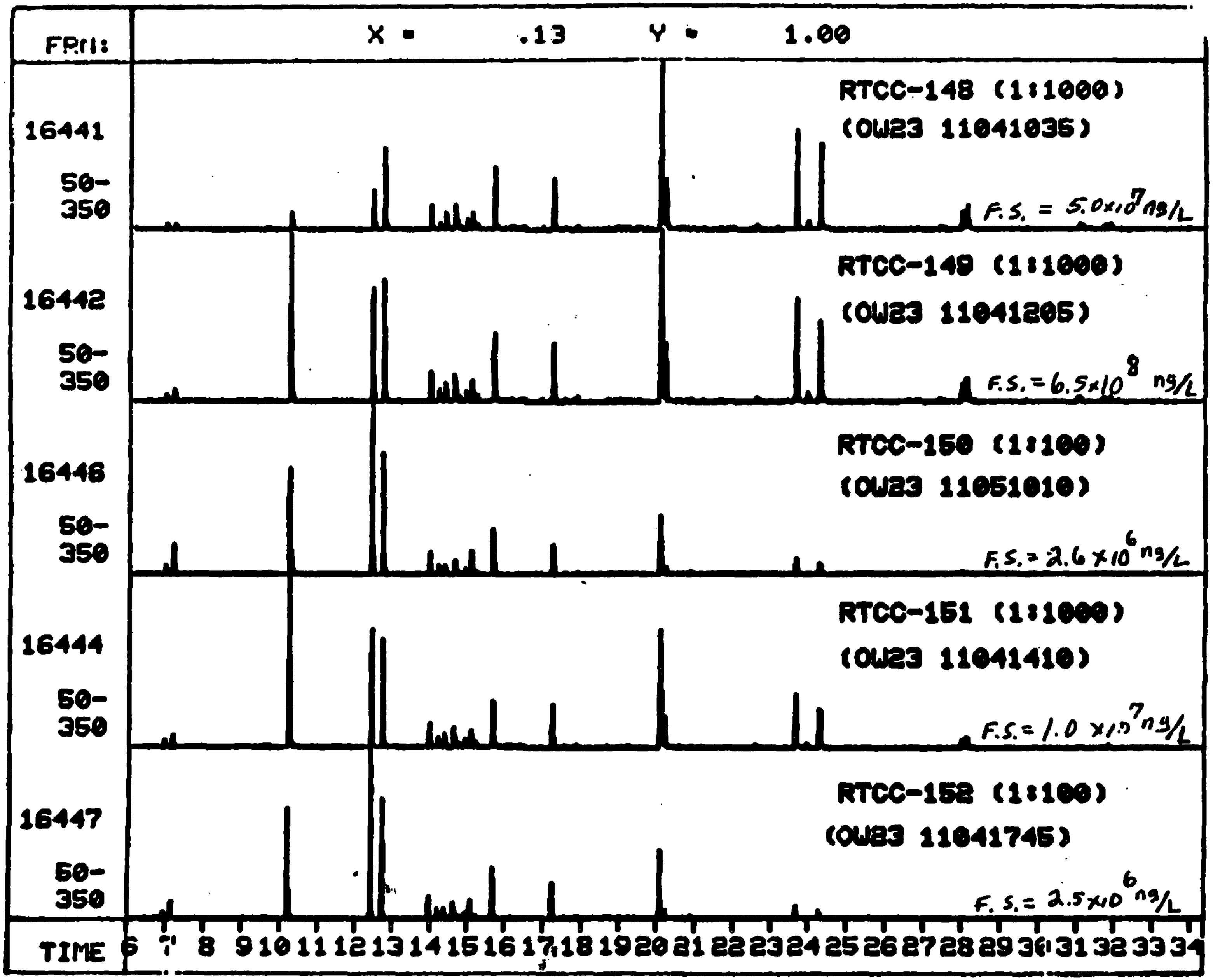
Feature Identification (Q. Mass)	Feature Number	Feature L.O.D.[a]	Sample Identification: 148 (dil 1:1000)	149 (dil 1:1000)	150 (dil 1:100)	151 (dil 1:1000)	152 (dil 1:100)
			Concentration (ng/L)				
Fluoranthene (202)	31	300	2.6×10^{5}	3.6×10^{5}	3.5×10^{4}	2.1×10^{5}	2.4×10^{4}
Pyrene (202)	32	900	1.9×10^{5}	2.8×10^{5}	2.7×10^{4}	1.7×10^{5}	1.5×10^{4}
Benzo(a)anthracene (228)	33	100	1.2×10^{5}	2.9×10^{5}	1.1×10^{4}	9.2×10^{4}	6.4×10^{3}
Chrysene (228)	34	800	2.4×10^{5}	2.1×10^{5}	9.2×10^{3}	1.3×10^{5}	5.9×10^{3}
Benzo(b)fluoranthene (252)	36	2.4×10^{3}	2.9×10^{3}	2.6×10^{5}	3.6×10^{4}	2.9×10^{5}	1.5×10^{4}
Benzo(k)fluoranthene (252)	37	2.4×10^{3}	2.9×10^{3}	2.6×10^{5}			
Benzo(e)pyrene (as 39) (252)	38	1.3×10^{3}	3.8×10^{4}	2.5×10^{4}	2.4×10^{3}	1.9×10^{4}	1.1×10^{3}
Benzo(a)pyrene (252)	39	1.3×10^{3}	5.7×10^{4}	6.5×10^{4}	4.2×10^{3}	3.0×10^{4}	1.9×10^{3}
Perylene (as 39) (252)	40	1.3×10^{3}	6.9×10^{3}	8.5×10^{3}	9.0×10^{2}	5.8×10^{3}	ND[b]
Indeno(1,2,3,cd)pyrene (276)	45	2.3×10^{3}	2.9×10^{4}	2.4×10^{4}	2.7×10^{3}	2.3×10^{4}	ND
Dibenz(a,h)anthracene (278)	66	1.9×10^{3}	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene (276)	46	1.4×10^{3}	6.3×10^{3}	1.2×10^{4}	1.7×10^{3}	1.2×10^{4}	ND
Acridine (178)	67	2.9×10^{3}	ND	2.5×10^{5}	1.5×10^{4}	ND	1.1×10^{4}

TABLE 30 (continued)

Feature Identification (Q. Mass)	Feature Number	Feature L.O.D.[a]	Sample Identification: 148 (dil 1:1000)	149 (dil 1:1000)	150 (dil 1:100)	151 (dil 1:1000)	152 (dil 1:100)	
			Concentration (ng/L)					
Carbazole (166)	68	1.9×10^3	2.4×10^4	6.6×10^4	3.6×10^4	3.5×10^4	3.3×10^4	
Anthracene-d_{10} (IS) (188)	21	-	25	25	25	25	25	
Surrogate Spiking Compound		Amount added (ng/L)	Recovery (%)					
Naphthalene-d_8 (136)	63	100	-	-	-	-	-	
Chrysene-d_{12} (240)	35	100	-	-	-	-	-	

[a]L.O.D. = limit of detection.

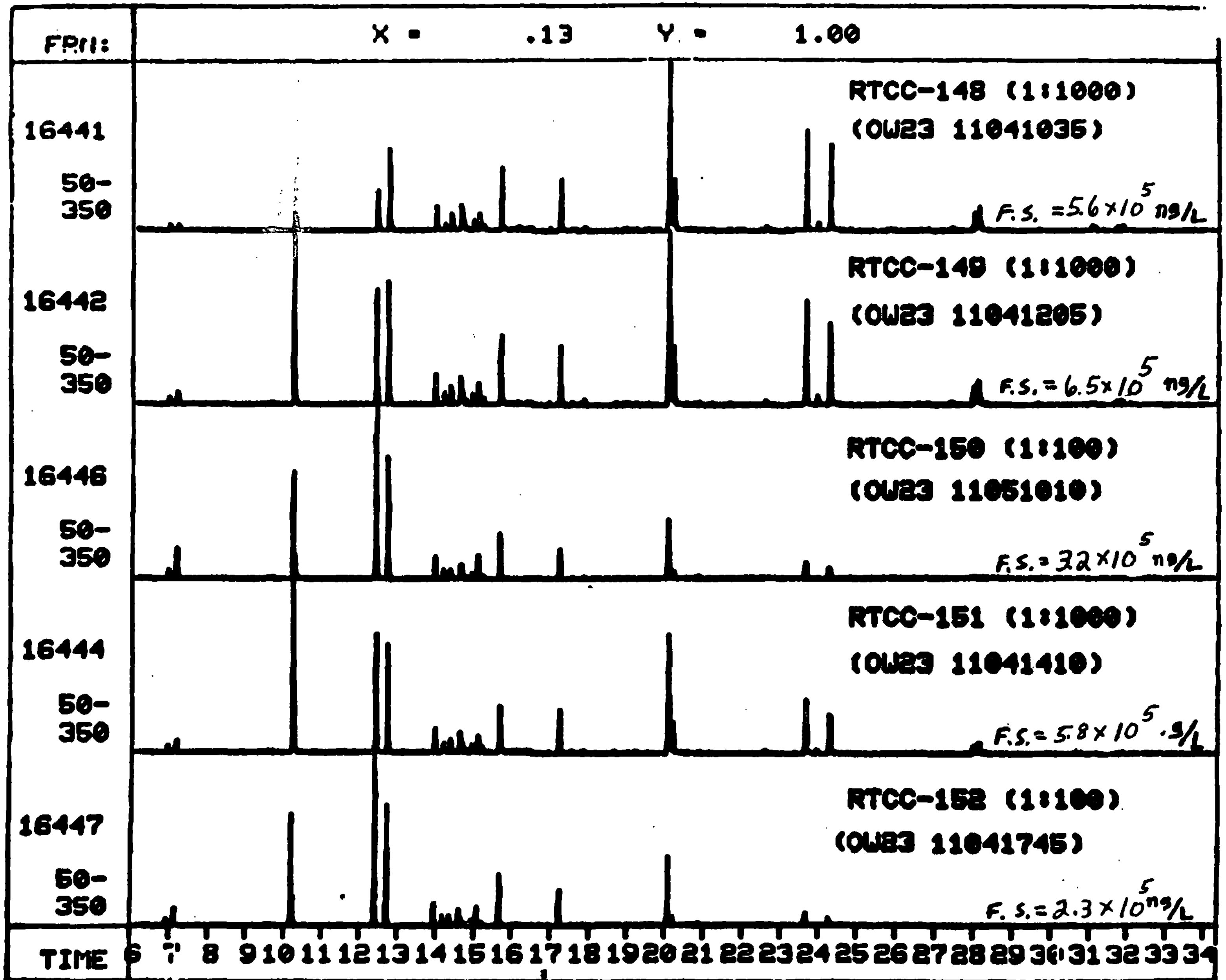
[b]ND = none detected with a detection limit given by the L.O.D. value (in ng/L) for each compound for 1:100 dilution.



PNA Screen - Cost Element A-2

ERT Task: 220

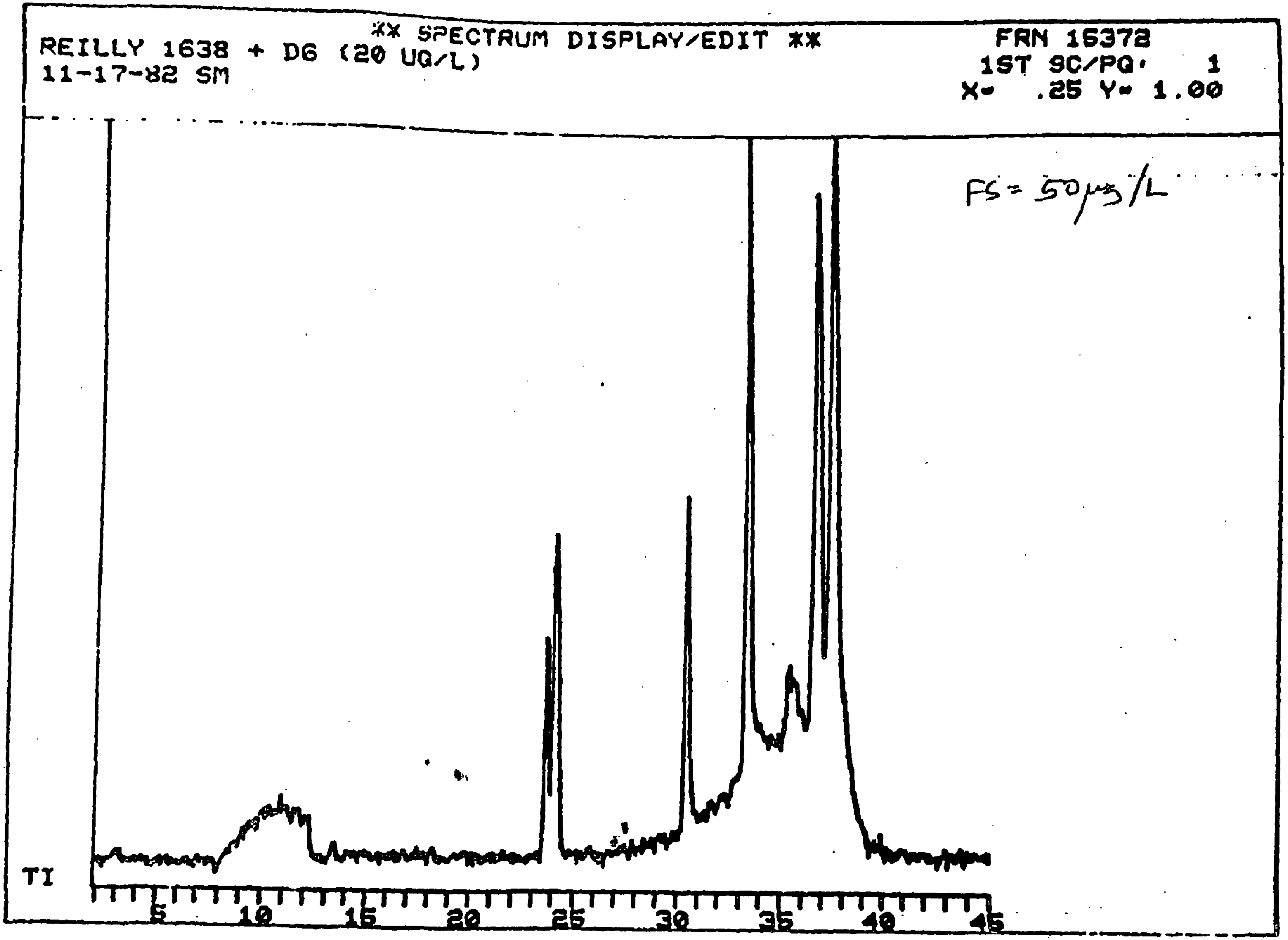
1063365



PNA Screen - Cost Element A-2

ERT Task: 220

1063366



VOA Screen - OW#23(11051010) - Cost Element A-3

ERT Task: 220

1063367

10/20/82 N.

Mike Kosatkau
Off. Waste Program Enforcement

20 OCT 82 15:27 7

EPA COMCENTER

382-4833

14

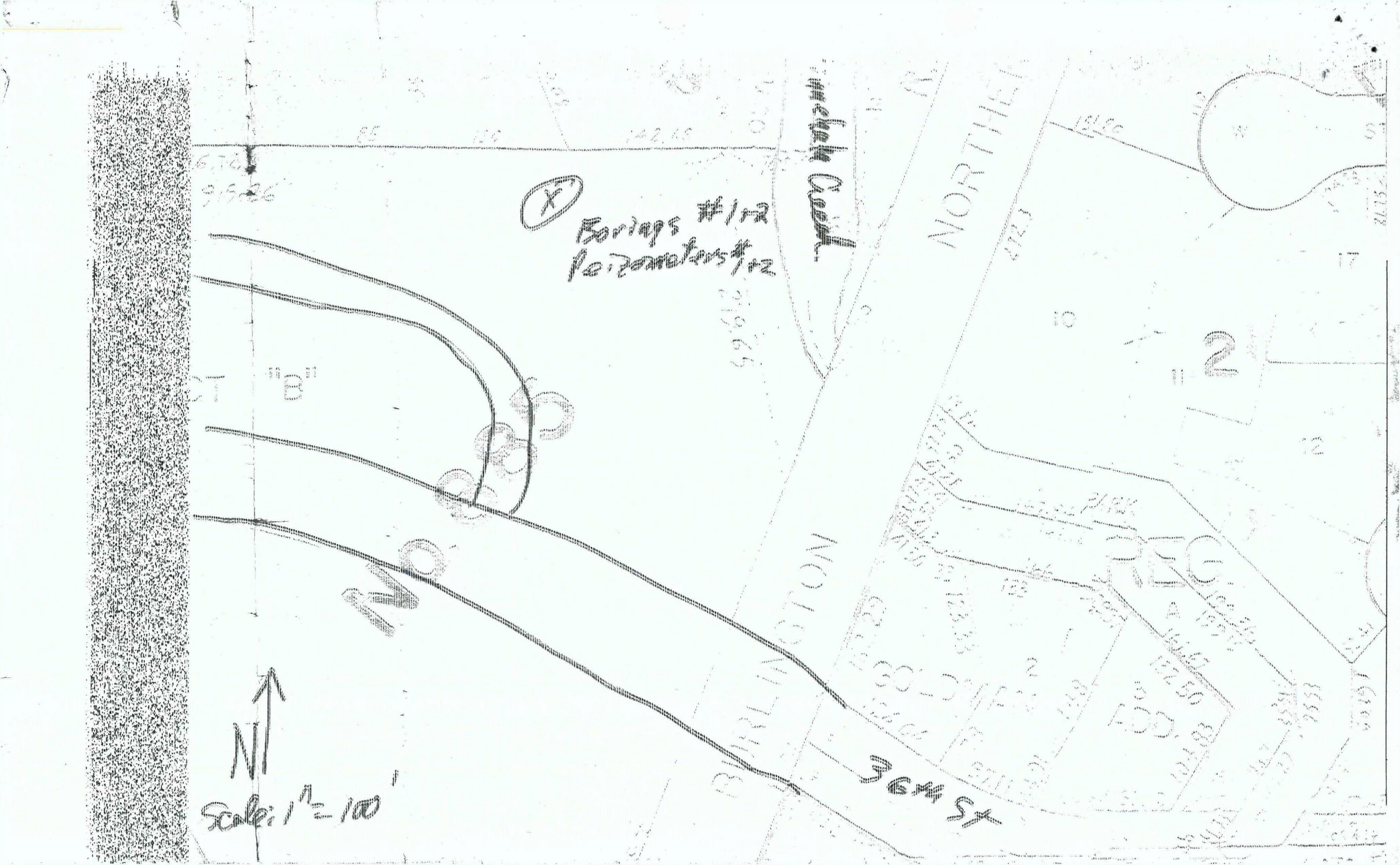
GCA Soils Boring Project
Reilly Tar Site
St. Louis Park, Minnesota

	Boring Number	Piezometer Number	USGS Project Number	Location	Detail Map	Purpose
PB 137	1	1		36th & Minnehaha Creek	Yes	Shake down; uncontaminated peat sample, drift well
PB 136	2	2		36th & Minnehaha Creek	Yes	Uncontaminated Platteville well; samples of uncontaminated drift soils
PB 138	3	3		34th & Wyoming near SLP #5	No	Platteville well at edge of known contamination; drift samples near edge of known contamination
PB 139	4	4		32nd & Rhode Island/ Quebec, Oak Hill Park	Yes	Drift well near area of suspected disposal, previously not investigated
PB 140	5	5		Near W23, Reilly deep well	No	Drift well to determine contamination of drift near major source of PdC/J contamination
PB 141	6	--		On Highway 7, west of Louisiana Ave. Extension	Yes	Drift boring to determine effect of highway construction on lacustrian deposits
PB 142	7	--		Walker Ave. and Louisiana Ave. Extension	Yes	Drift boring to determine northern extent of contamination in major disposal area
PB 144	8	--		400' west of Boring #7	Yes	"
	9	--		(Reserve)		If heavy contamination found in boring #7 or 8, wait til second round. If contamination not found, place near USGS W31

Mike Kosslag
O.Z. Waste Program
Enforcement

GCA Soils Boring Project
Reilly Tar Site
St. Louis Park, Minnesota

Boring Number	Piezometer Number	USGS Project Number	Location	Detail Map	Purpose
1	1		36th & Minnehaha Creek	Yes	Shake down; uncontaminated peat sample, drift well
2	2		36th & Minnehaha Creek	Yes	Uncontaminated Platteville well; samples of uncontaminated drift soils
3	3		34th & Wyoming near SLP #5	No	Platteville well at edge of known contamination; drift samples near edge of known contamination
4	4		32nd & Rhode Island/ Quebec, Oak Hill Park	Yes	Drift well near area of suspected disposal, previously not investigated
5	5		Near W23, Reilly deep well	No	Drift well to determine contamination of drift near major source of PAH contamination
6	--		On Highway 7, west of Louisiana Ave. Extension	Yes	Drift boring to determine effect of highway construction on lacustrian deposits
7	--		Walker Ave. and Louisiana Ave. Extension	Yes	Drift boring to determine northern extent of contamination in major disposal area
8	--		400' west of Boring #7	Yes	"
9	--		(Reserve)		If heavy contamination found in boring #7 or 8, wait til second round. If contamination not found, place near USGS W)


Borings #1+2
Piezometers #1+2
NORTHE
BURLINGTON
36th St
Scale: 1" = 100'
N

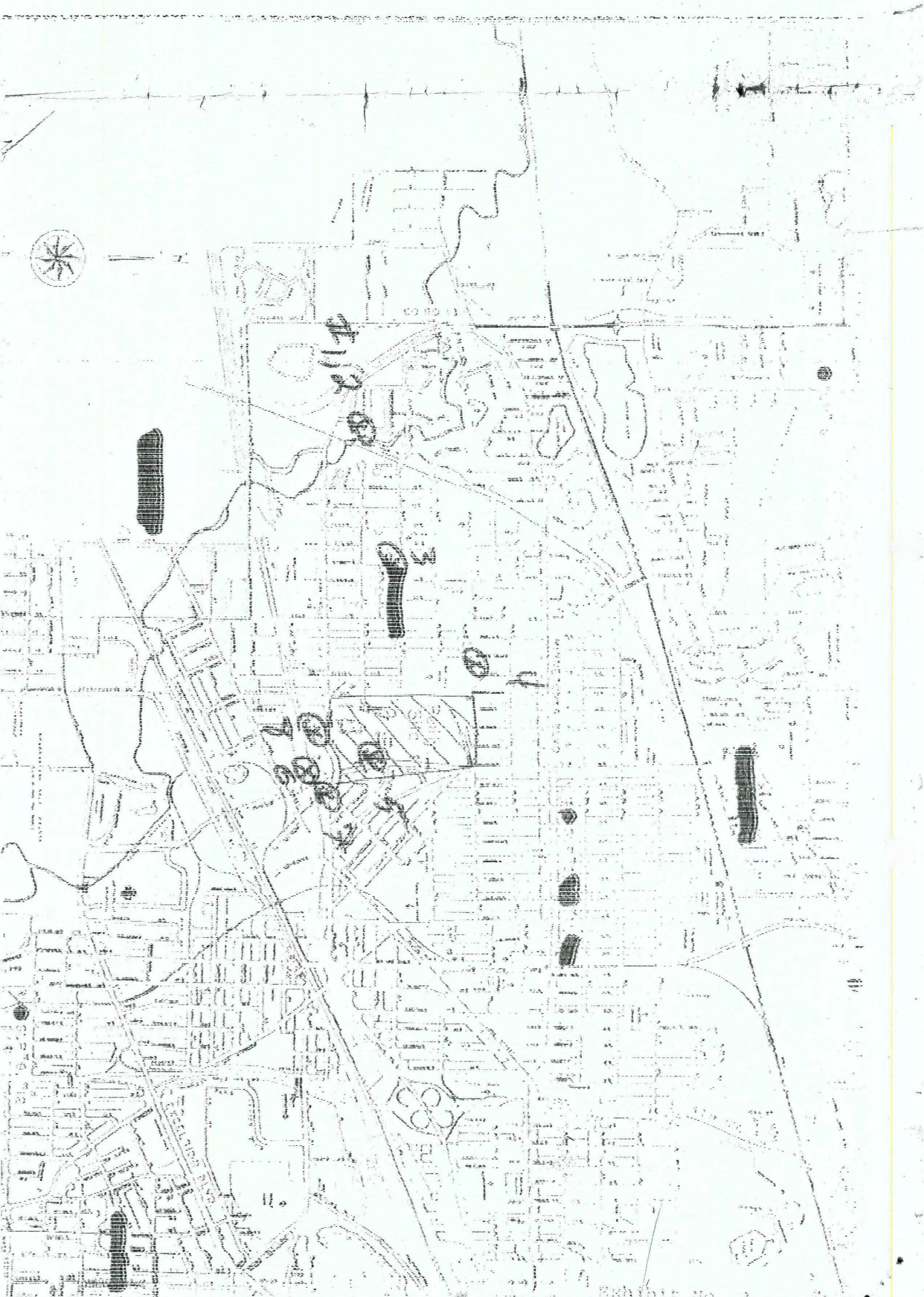
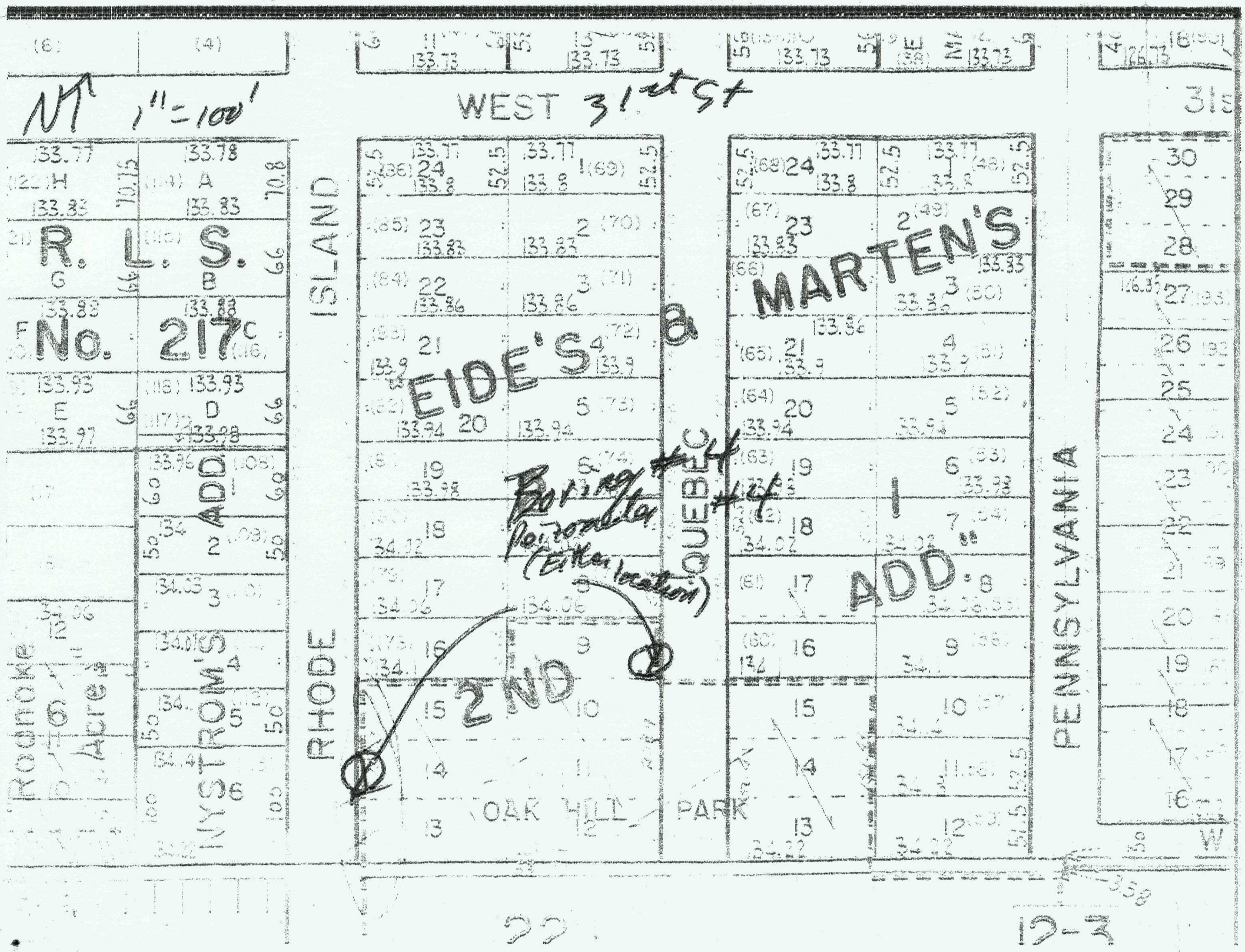
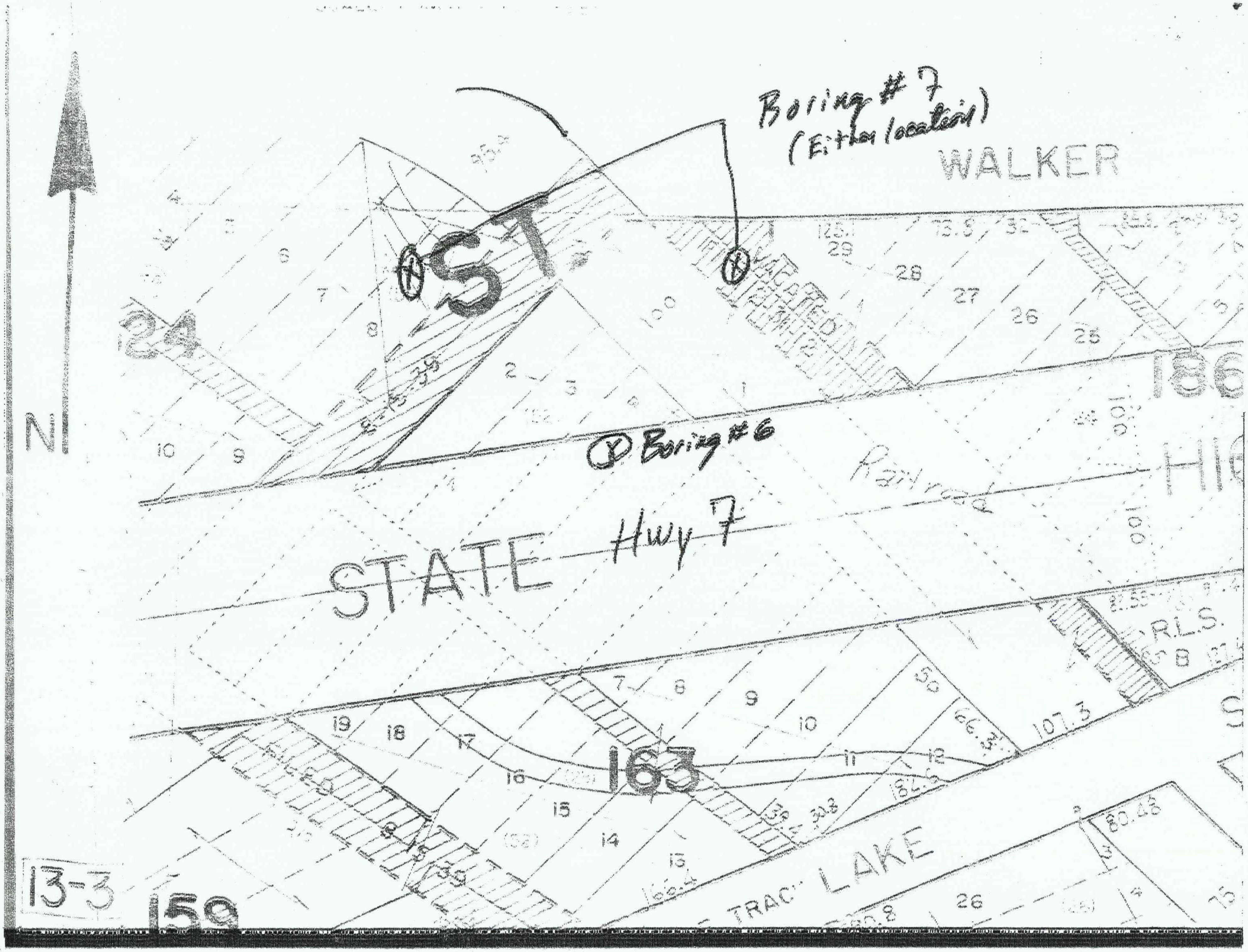
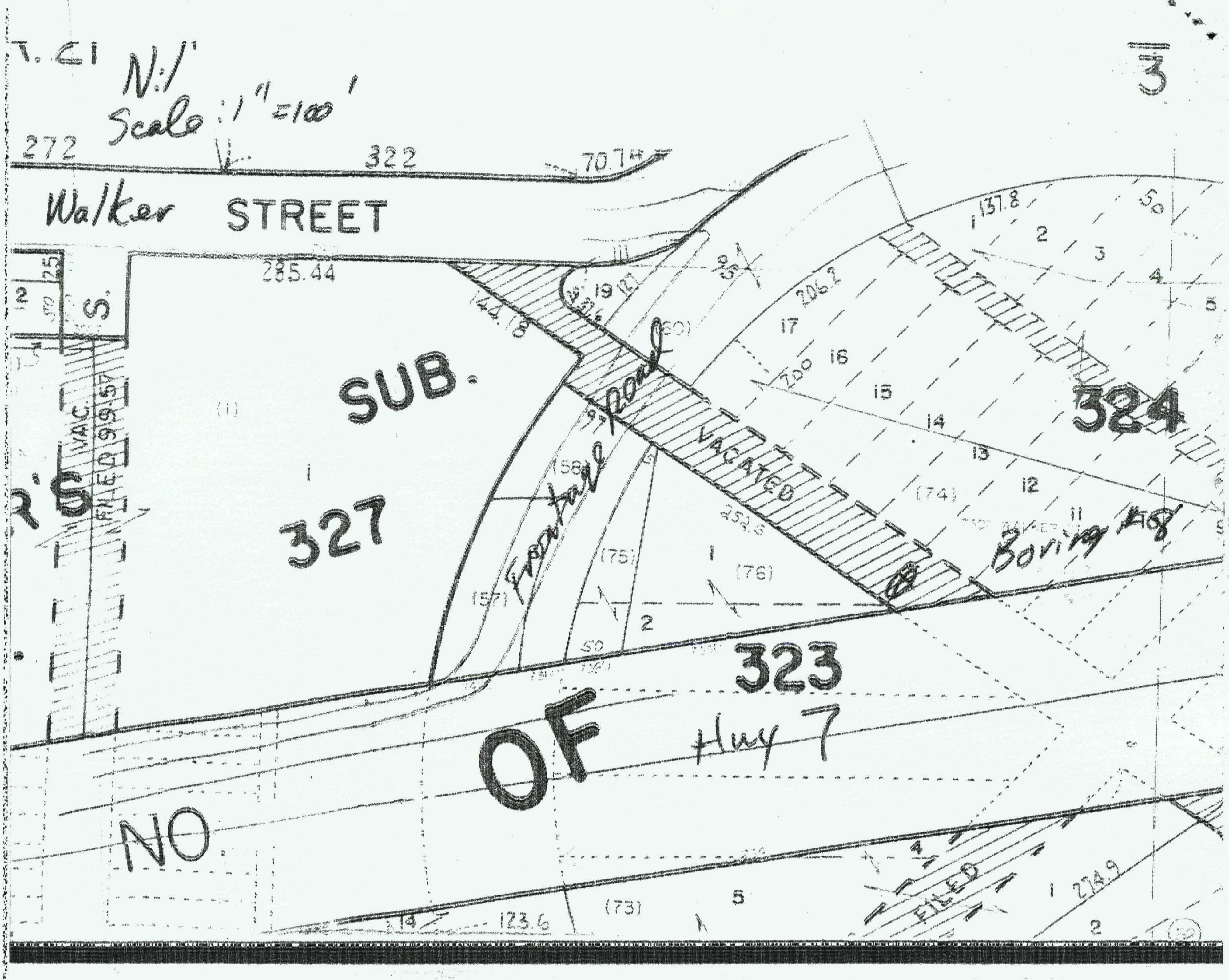


Exhibit No. 2



N
1" = 100'
WEST 31st St
R. L. S.
No. 217
NYSTROM'S ADD.
RHODE ISLAND
EIDE'S & MARTEN'S 2ND ADD.
QUEBEC
PENNSYLVANIA
OAK HILL PARK
Roanoke Acres
Boring #4
Piezometer #4
(Either location)
22
12-3


Boring # 7
(Either location)
WALKER
ST
Boring #6
Railroad
Hwy 7
STATE
R.L.S.
LAKE
N
24
186
163
159
13-3



3
N:/
Scale: 1" = 100'
272
322
70.74
Walker STREET
285.44
144.18
SUB.
327
VAC.
VACATED
Frontage Road
206.2
137.8
200
253.5
(74)
(75)
(76)
(57)
(58)
(60)
324
323
Boring #8
OF
Hwy 7
NO.
FILED
123.6
274.9
(73)

9/24/82
N.

GCA
GCA CORPORATION
Technology Division
213 Burlington Road
Bedford, Massachusetts 01730
Telephone: 617-275-5444
Telex: 92-3339

September 24, 1982

Mike Kosakowski
U.S. Environmental Protection Agency
Office of Hazardous Waste Enforcement
Fairchild Building, 2nd Floor
499 S. Capital, S.W.
Washington, D.C. 20460

Subject: EPA Contract No. 68-01-6316
(GCA 1-452-124)

Dear Mike:

Enclosed please find base-neutral extractables results for the following samples:

- MWCC 1/20/82
- Presscake 1/22/82
- Presscake 1/27/82
- Presscake 1/29/82

All samples were prepared as specified in Interim Methods for the Sampling and Analysis of Priority Pollutants in Sediments and Fish Tissue (U.S. EPA, EMSL, Cinn., Ohio). Subsequent Priority Pollutant analyses were provided via GC/MS using a fused silica capillary column. Please note that all component concentrations are reported in mg/kg (ppm) of wet sample. Results are also provided for a replicate of GCA 19106 spiked with several polynuclear aromatic components (Table 1).

Should you have any questions concerning the enclosed information please do not hesitate to contact me.

Sincerely,

Mike Rennekamp (GTH)

Mike Rennekamp
Senior Staff Scientist
Laboratory Analysis Department

cc: File 1-452-124

MER/mdp

TABLE I

Quality Control Sample

Spiked GCA 19106

Compound	Concentration mg/kg[a] Expected	Reported	% Recovery
Acenaphthylene	3.6	2.8	78
Phenanthrene	1.4	1.4[b]	100
Benzo (a) anthracene	2.1	2.1	100
Fluoranthene	3.6	3.8	105

a. Wet Weight Values

b. Corrected for Amount in the Sample (GCA 19106)

Project 1-452-124C | GCA Control No. 19106

DATA REPORT SHEET
Base/Neutral Extractables

Sample I.D. Presscake 1/27/82 | Analysis Date 7/14/82

Sample Matrix Sludge | Instrument HP 5985 GC/MS

Parameter	Ion Used to Quantitate	Concentration (mg/kg)	Remarks
acenaphthene		ND	
acenaphthylene		ND	
anthracene		ND	
phenanthrene	178	1.3	
benzo(a)anthracene		ND	
chrysene		ND	
benzo(a)pyrene		ND	
benzo(b)fluoranthene		ND	
benzo(k)fluoranthene		ND	
benzo(g,h,i)perylene		ND*	
indeno(1,2,3-cd)pyrene		ND*	
dibenzo(a,h)anthracene		ND*	
fluoranthene		ND	
pyrene		ND	
fluorene		ND	
naphthalene		ND	
2-chloronaphthalene		ND	
1,2-dichlorobenzene		ND	
1,3-dichlorobenzene		ND	
1,4-dichlorobenzene		ND	
1,2,4-trichlorobenzene		ND	
hexachlorobenzene		ND	
nitrobenzene		ND	
2,4-dinitrotoluene		ND	
2,6-dinitrotoluene		ND	
dimethyl phthalate		ND	
diethyl phthalate		ND	
di-n-butyl phthalate		ND	
dioctyl phthalate		ND	
butyl benzyl phthalate		ND	
bis(2-ethylhexyl) phthalate	149	58	
bis(chloromethyl) ether		ND	
bis(2-chloroethyl) ether		ND	
bis(2-chloroisopropyl) ether		ND	
4-bromophenyl phenyl ether		ND	
4-chlorophenyl phenyl ether		ND	
N-nitrosodimethyl amine		ND	
N-nitrosodiphenyl amine		ND	
N-nitrosodi-n-propyl amine		ND	
hexachloroethane		ND	
bis(2-chloroethoxy) methane		ND	
isophorone		ND	
hexachlorobutadiene		ND	
3,3'-dichlorobenzidine		ND*	
benzidine		ND*	
1,2-diphenylhydrazine		ND	
hexachlorocyclopentadiene		ND	
2,3,7,8-tetrachlorodibenzo-p-dioxin		ND	

ND = < 1 mg/kg
ND* = < 4 μg/kg

GCA CORPORATION
Technology Division

Project 1-452-124C GCA Control No. 19162

DATA REPORT SHEET
Base/Neutral Extractables

Sample I.D. Presscake 1/29/82 Analysis Date 8/28/82

Sample Matrix Sludge Instrument HP 5985 GC/MS

Parameter	Ion Used to Quantitate	Concentration (mg/kg)	Remarks
acenaphthene		ND	
acenaphthylene		ND	
anthracene		ND	
phenanthrene	178	1.1	
benzo(a)anthracene		ND	
chrysene		ND	
benzo(a)pyrene		ND	
benzo(b)fluoranthene		ND	
benzo(k)fluoranthene		ND	
benzo(g,h,i)perylene		ND*	
indeno(1,2,3-cd)pyrene		ND*	
dibenzo(a,h)anthracene		ND*	
fluoranthene		ND	
pyrene		ND	
fluorene		ND	
naphthalene		ND	
2-chloronaphthalene		ND	
1,2-dichlorobenzene		ND	
1,3-dichlorobenzene		ND	
1,4-dichlorobenzene		ND	
1,2,4-trichlorobenzene		ND	
hexachlorobenzene		ND	
nitrobenzene		ND	
2,4-dinitrotoluene		ND	
2,6-dinitrotoluene		ND	
dimethyl phthalate		ND	
diethyl phthalate		ND	
di-n-butyl phthalate		ND	
dioctyl phthalate		ND	
butyl benzyl phthalate		ND	
bis(2-ethylhexyl) phthalate	149	29	
bis(chloromethyl) ether		ND	
bis(2-chloroethyl) ether		ND	
bis(2-chloroisopropyl) ether		ND	
4-bromophenyl phenyl ether		ND	
4-chlorophenyl phenyl ether		ND	
N-nitrosodimethyl amine		ND	
N-nitrosodiphenyl amine		ND	
N-nitrosodi-n-propyl amine		ND	
hexachloroethane		ND	
bis(2-chloroethoxy) methane		ND	
isophorone		ND	
hexachlorobutadiene		ND	
3,3'-dichlorobenzidine		ND*	
benzidine		ND*	
1,2-diphenylhydrazine		ND	
hexachlorocyclopentadiene		ND	
2,3,7,8-tetrachlorodibenzo-p-dioxin		ND	

ND = < 1 mg/kg
ND* = < 4 mg/kg

GCA CORPORATION
Technology Division
GCA

Project 1-452-124C GCA Control No. 18941

DATA REPORT SHEET
Base/Neutral Extractables

Sample I.D. MWCC 1/20/82 Analysis Date 7/14/82

Sample Matrix Sludge Instrument HP 5985 GC/MS

Parameter	Ion Used to Quantitate	Concentration (mg/kg)	Remarks
acenaphthene		ND	
acenaphthylene		ND	
anthracene		ND	
phenanthrene	178	1.2	
benzo(a)anthracene		ND	
chrysene		ND	
benzo(a)pyrene		ND	
benzo(b)fluoranthene		ND	
benzo(k)fluoranthene		ND	
benzo(g,h,i)perylene		ND*	
indeno(1,2,3-cd)pyrene		ND*	
dibenzo(a,h)anthracene		ND*	
fluoranthene		ND	
pyrene		ND	
fluorene		ND	
naphthalene	128	1.4	
2-chloronaphthalene		ND	
1,2-dichlorobenzene		ND	
1,3-dichlorobenzene		ND	
1,4-dichlorobenzene		ND	
1,2,4-trichlorobenzene		ND	
hexachlorobenzene		ND	
nitrobenzene		ND	
2,4-dinitrotoluene		ND	
2,6-dinitrotoluene		ND	
dimethyl phthalate		ND	
diethyl phthalate		ND	
di-n-butyl phthalate		ND	
dioctyl phthalate		ND	
butyl benzyl phthalate		ND	
bis(2-ethylhexyl) phthalate	149	67	
bis(chloromethyl) ether		ND	
bis(2-chloroethyl) ether		ND	
bis(2-chloroisopropyl) ether		ND	
4-bromophenyl phenyl ether		ND	
4-chlorophenyl phenyl ether		ND	
N-nitrosodimethyl amine		ND	
N-nitrosodiphenyl amine		ND	
N-nitrosodi-n-propyl amine		ND	
hexachloroethane		ND	
bis(2-chloroethoxy) methane		ND	
isophorone		ND	
hexachlorobutadiene		ND	
3,3'-dichlorobenzidine		ND*	
benzidine		ND*	
1,2-diphenylhydrazine		ND	
hexachlorocyclopentadiene		ND	
2,3,7,8-tetrachlorodibenzo-p-dioxin		ND	

ND = < 1 mg/kg
ND* = < 4 mg/kg

GCA CORPORATION
Technology Division
GCA

Project 1-452-124C GCA Control No. 18982

DATA REPORT SHEET
Base/Neutral Extractables

Sample I.D. Presscake 1/22/82 Analysis Date 8/2/82

Sample Matrix Sludge Instrument HP 5985 GC/MS

Parameter	Ion Used to Quantitate	Concentration (mg/kg)	Remarks
acenaphthene		ND	
acenaphthylene		ND	
anthracene		ND	
phenanthrene		ND	
benzo(a)anthracene		ND	
chrysene		ND	
benzo(a)pyrene		ND	
benzo(b)fluoranthene		ND	
benzo(k)fluoranthene		ND	
benzo(g,h,i)perylene		ND*	
indeno(1,2,3-cd)pyrene		ND*	
dibenzo(a,h)anthracene		ND*	
fluoranthene		ND	
pyrene		ND	
fluorene		ND	
naphthalene		ND	
2-chloronaphthalene		ND	
1,2-dichlorobenzene		ND	
1,3-dichlorobenzene		ND	
1,4-dichlorobenzene		ND	
1,2,4-trichlorobenzene		ND	
hexachlorobenzene		ND	
nitrobenzene		ND	
2,4-dinitrotoluene		ND	
2,6-dinitrotoluene		ND	
dimethyl phthalate		ND	
diethyl phthalate		ND	
di-n-butyl phthalate		ND	
dioctyl phthalate		ND	
butyl benzyl phthalate		ND	
bis(2-ethylhexyl) phthalate	149	61	
bis(chloromethyl) ether		ND	
bis(2-chloroethyl) ether		ND	
bis(2-chloroisopropyl) ether		ND	
4-bromophenyl phenyl ether		ND	
4-chlorophenyl phenyl ether		ND	
N-nitrosodimethyl amine		ND	
N-nitrosodiphenyl amine		ND	
N-nitrosodi-n-propyl amine		ND	
hexachloroethane		ND	
bis(2-chloroethoxy) methane		ND	
isophorone		ND	
hexachlorobutadiene		ND	
3,3'-dichlorobenzidine		ND*	
benzidine		ND*	
1,2-diphenylhydrazine		ND	
hexachlorocyclopentadiene		ND	
2,3,7,8-tetrachlorodibenzo-p-dioxin		ND	

ND = < 1 mg/kg
ND* = < 4 mg/kg

GCA CORPORATION
Technology Division
GCA

PAH Samples
St. Louis PARK, Minnesota
Municipal Raw Water Samples

DATE Collected: December 9, 1981

FIELD #		Municipal Well #	
1	g	15	(code as #17)
2	g	15	
3	l	14	
4	l	14	
5	l	14	
6	l	14	
7	l	14	
8	g	16	

$\boxed{\text{SLP 15}}$ = Municipal Well #

$\boxed{1}$ = FIELD #

PAH Samples
St. Louis Park, Minnesota
Municipal Raw Water Samples

Date Collected: December 9, 1981

Field number	Municipal Well number
1	17
2	15
3	14
4	14
5	14
6	14
7	14
8	16

recorded on bottle as follows:
$\boxed{\text{SLP 15}}$ = municipal well no.
$\boxed{2}$ = field no.

Eight municipal raw water samples were collected on December 9, 1981 from the St Louis Park, Mn. municipal water system. The samples were collected between 1 p.m. and 3 p.m. according to standard Health Department methods. The samples were placed in 2 Coleman ice chests and packed with ice. The samples were turned over to Rick Ferguson at 4:30 p.m. December 9, 1981 X [illegible]

Richard R. Ferguson - took possession at 430 pm on December 9, 1981.

Samples were left with guard at 5:00 pm for pick up at 5:15 by Federal Express.

Analysis of Polynuclear Aromatic Hydrocarbons
EPA Method 610

Instrument Conditions

1) Dupont Model 850 High Pressure Liquid Chromatograph.

2) Perkin-Elmer Analytical PAH 0258-0082 column.

3) Perkin-Elmer 650-10S Fluorescence Spectrophotometer; 15 nm slit setting; 280 nm Excitation, 389 nm Emission.

4) Perkin-Elmer LC-75 UV Spectrophotometric detector; 254 nm.

5) Gradient Elution - Linear gradient of 30% Acetonitrile/70% water, increasing to 100% Acetonitrile over 60 minutes; flow rate of 1.0 ml./min.

6) Injection volume - 30 microliters.

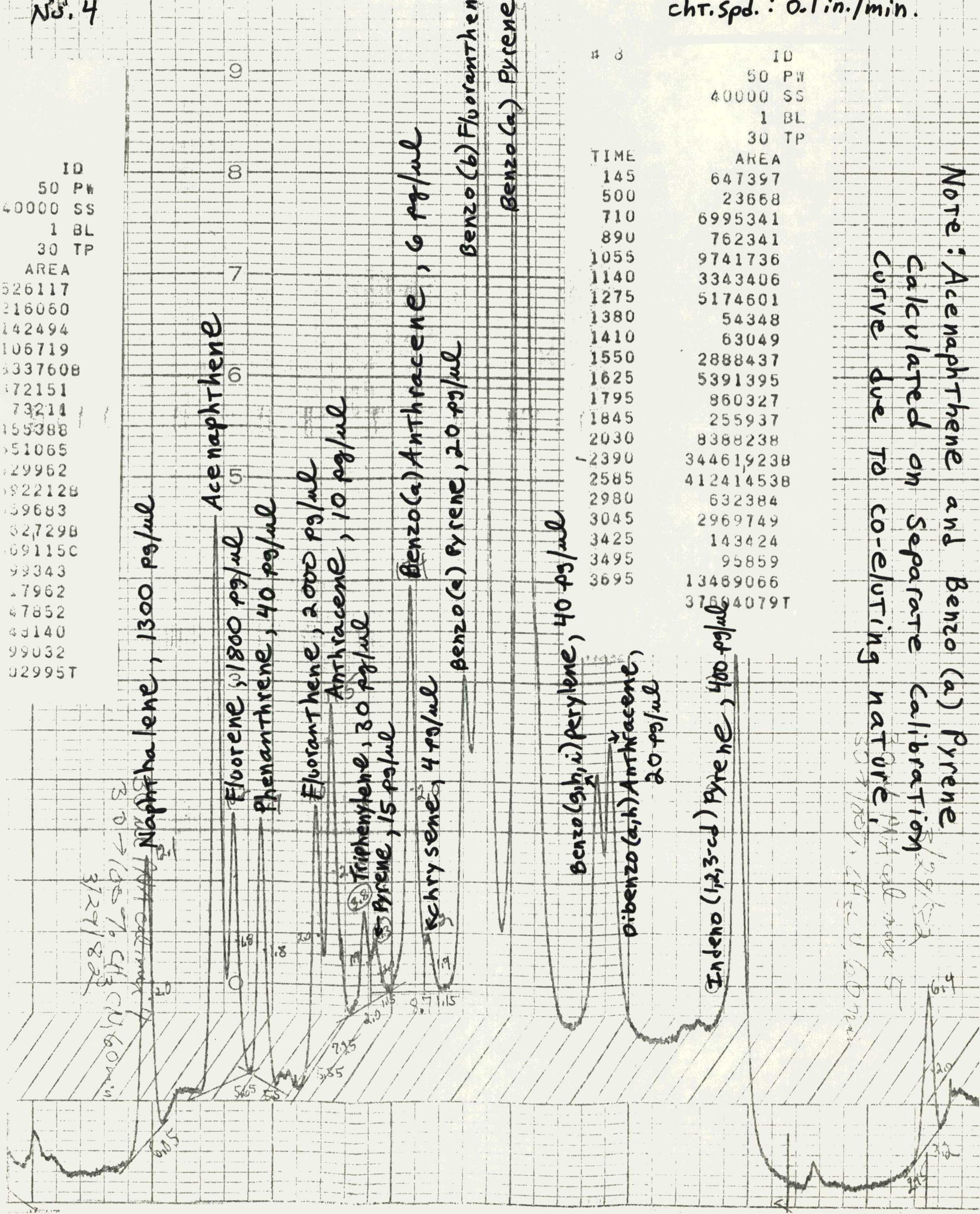
Calibration Standard No. 4

30 microliter injectio
Flow : 1.0 ml./min.
cht. Spd. : 0.1 in./min.

ID	
50	PW
40000	SS
1	BL
30	TP
AREA	
526117	
216060	
142494	
106719	
3337608	
372151	
73211	
155388	
51065	
29962	
922128	
59683	
627298	
09115C	
99343	
17962	
47852	
43140	
99032	
02995T	

8

TIME	AREA
	ID
	50 PW
	40000 SS
	1 BL
	30 TP
145	647397
500	23668
710	6995341
890	762341
1055	9741736
1140	3343406
1275	5174601
1380	54348
1410	63049
1550	2888437
1625	5391395
1795	860327
1845	255937
2030	8388238
2390	344619238
2585	412414538
2980	632384
3045	2969749
3425	143424
3495	95859
3695	13469066
	37694079T



Note: Acenaphthene and Benzo (a) Pyrene calculated on separate calibration curve due to co-eluting nature.

Calibration Standards for Naphthalene and Acenaphthene

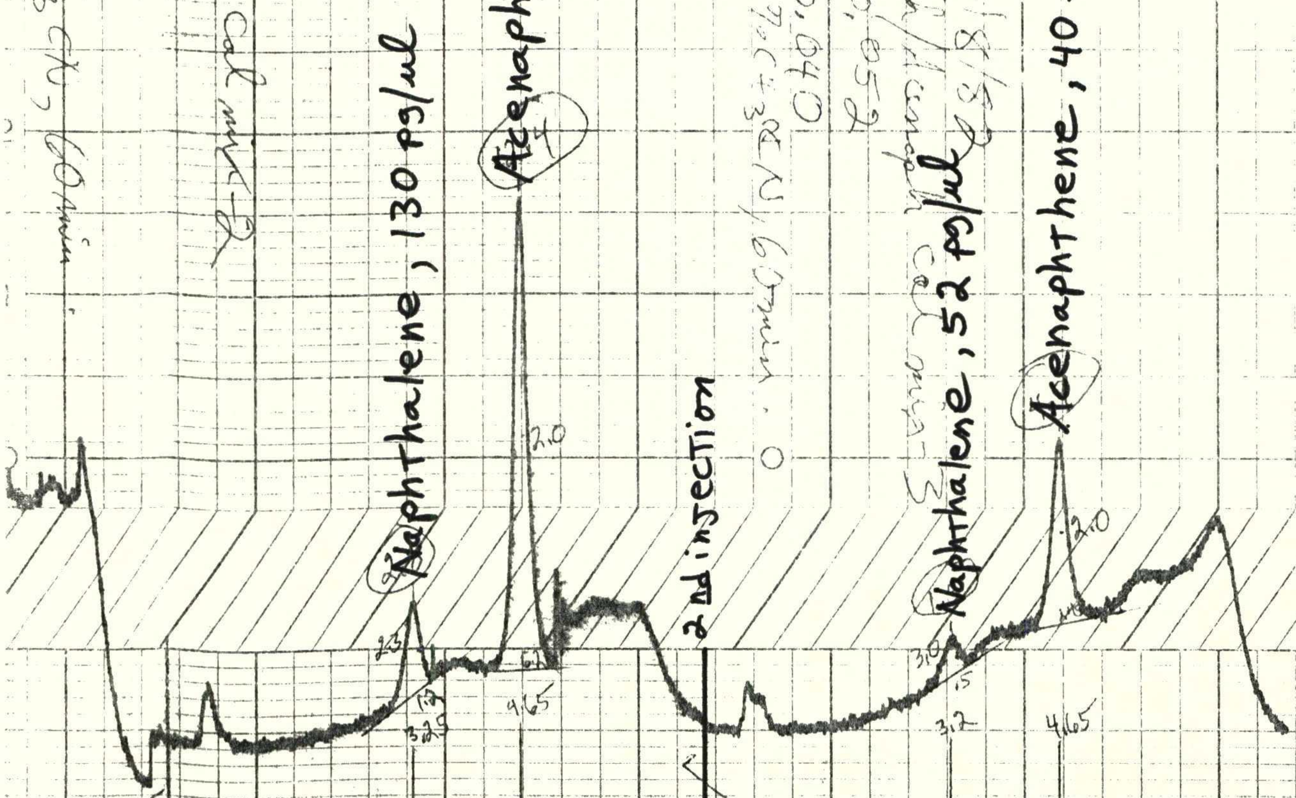
30 microliter injection
Flow : 1.0 ml./min.
Cht. Spd. : 0.1 in./min.

# 4	ID
	50 PW
	40000 SS
	1 BL
	30 TP
TIME	AREA
134	795584
544	52238
789	1049987
864	45932
924	77850
1124	6595159
1269	268035
1349	267651
	9172438T

# 5	ID
	50 PW
	40000 SS
	1 BL
	30 TP
TIME	AREA
149	757101
469	37094
599	57590
779	464262
929	255130
1114	2960336
1364	445521
1599	4640333
	96173671T

30 ul Naph/Acen, Cal mix-2
Naph - 0.13
Acen - 0.10
30 → 180 °C, #3 CN, 60 min.

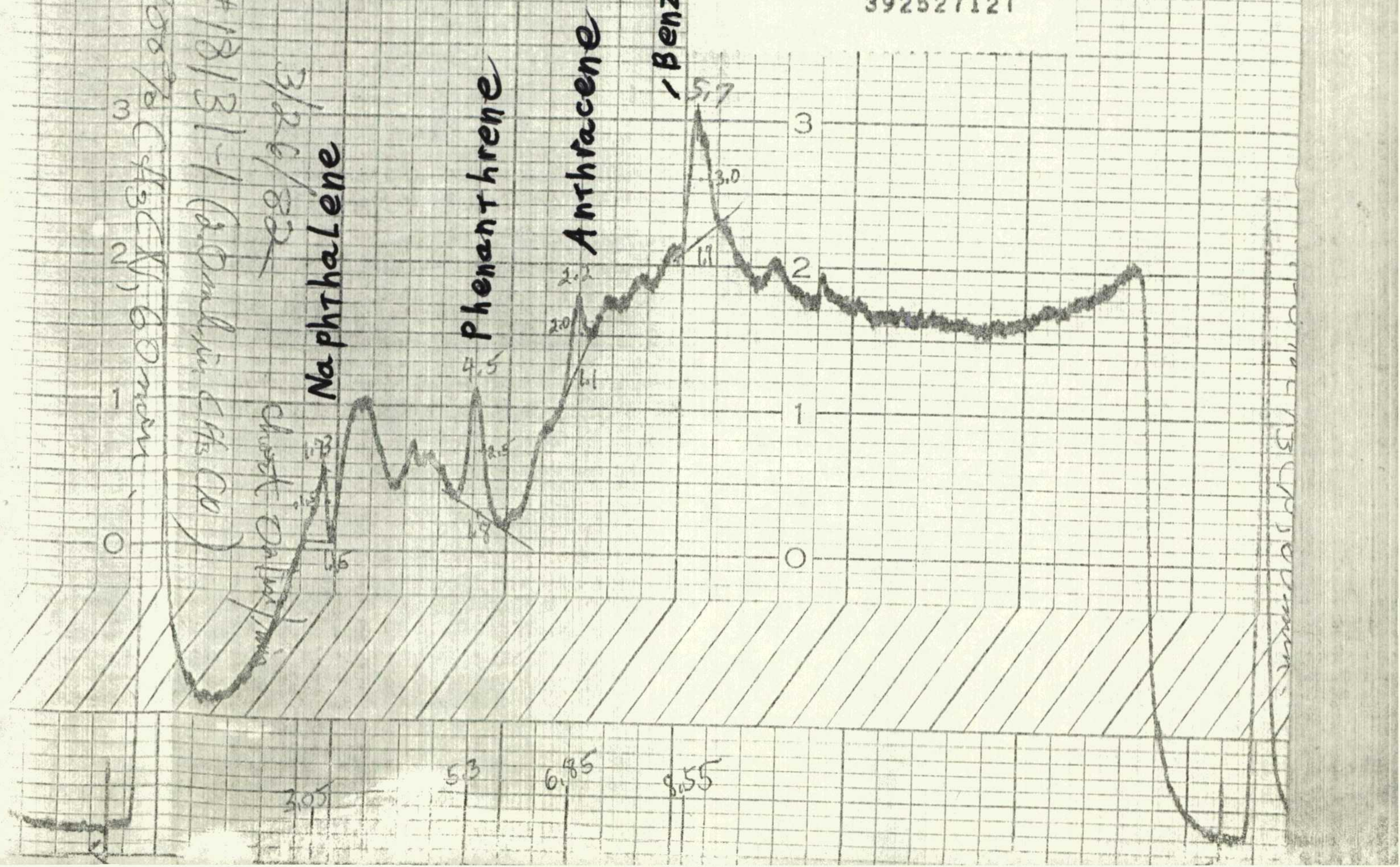
4/8/83
30 ul Naph/Acenaph Cal mix-3
Naph - 0.052
acen - 0.040
30 → 180 °C + 3°C/N, 60 min.



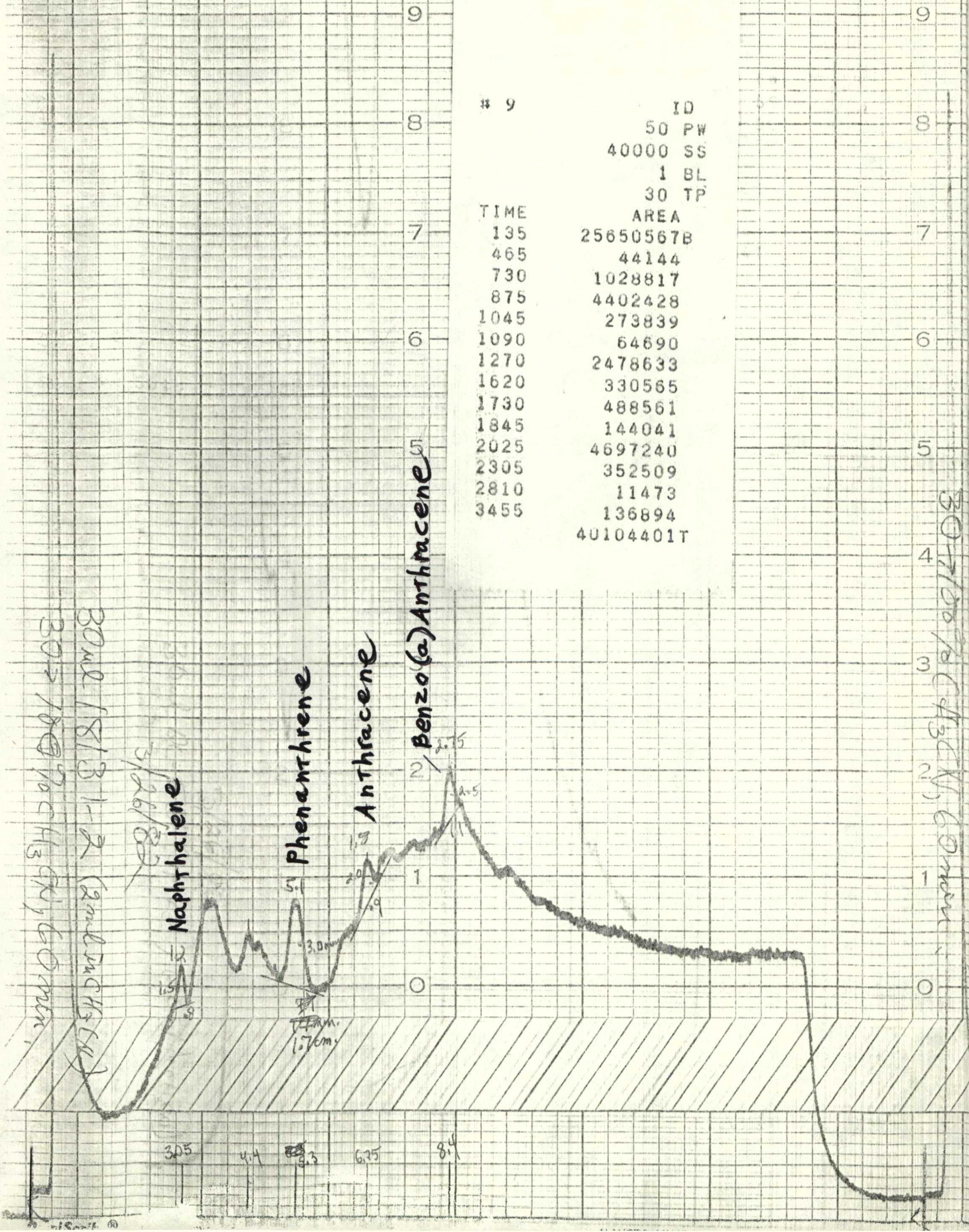
OmniScribe® CHART TYPE

GCA No. 18131-1
SLP-14

#10	ID
	50 PW
	40000 SS
	1 BL
	30 TP
TIME	AREA
136	24231371
741	1084934
871	4326934
1056	207227
1111	169796
1281	2144431
1641	572952
1756	245007
1866	208939
1981	165209
2056	4602060
2341	663593
2511	315029
2636	78560
2781	46067
2846	20671
2891	5611
3116	40817
3286	123504
	39252712T



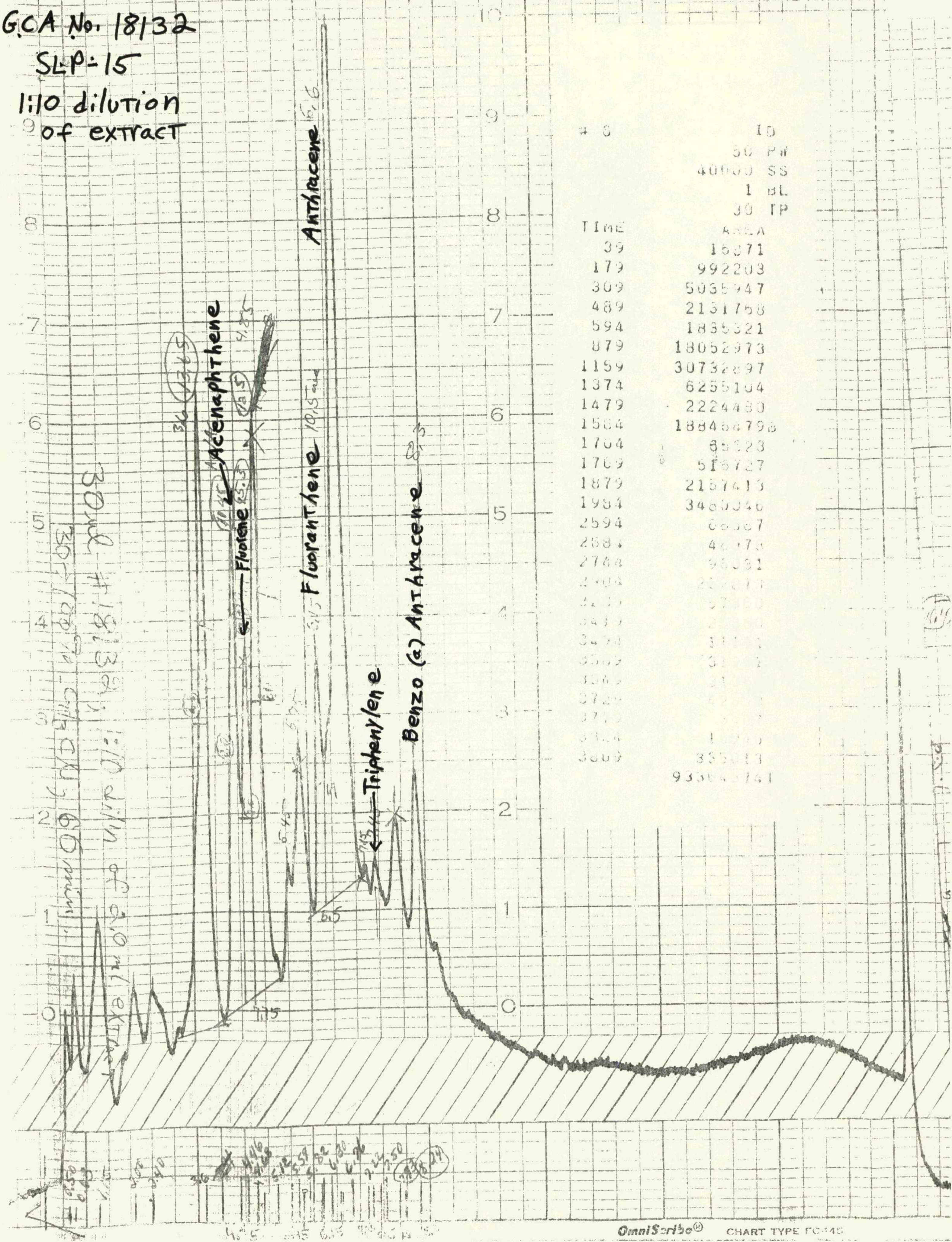
GCA No. 18131-2
SLP-14



9

	ID
	50 PW
	40000 SS
	1 BL
	30 TP
TIME	AREA
135	25650567B
465	44144
730	1028817
875	4402428
1045	273839
1090	64690
1270	2478633
1620	330565
1730	488561
1845	144041
2025	4697240
2305	352509
2810	11473
3455	136894
	40104401T

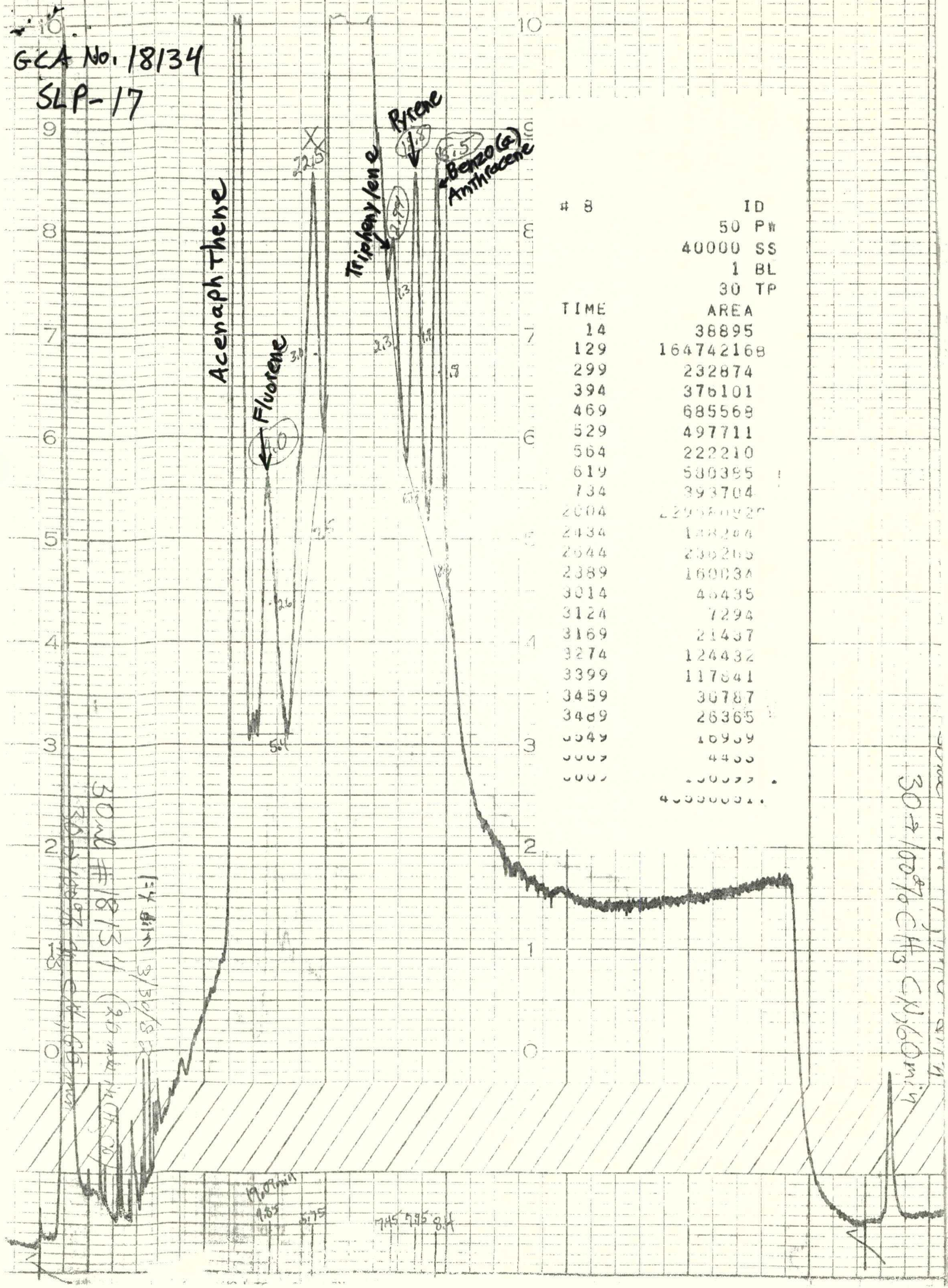
G.C.A. No. 18132
SLP-15
1:10 dilution
of extract



#8 ID
50 PW
40000 SS
1 BL
30 TP

TIME	AREA
39	16371
179	992203
309	5035[illegible]47
489	2131758
594	1835[illegible]21
879	18052973
1159	30732[illegible]97
1374	6255104
1479	2224480
1584	188454796
1704	85[illegible]23
1769	516727
1879	2157413
1984	3460046
2594	[illegible]7
2684	4[illegible]73
2744	[illegible]31
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
3869	335013
	933[illegible]741

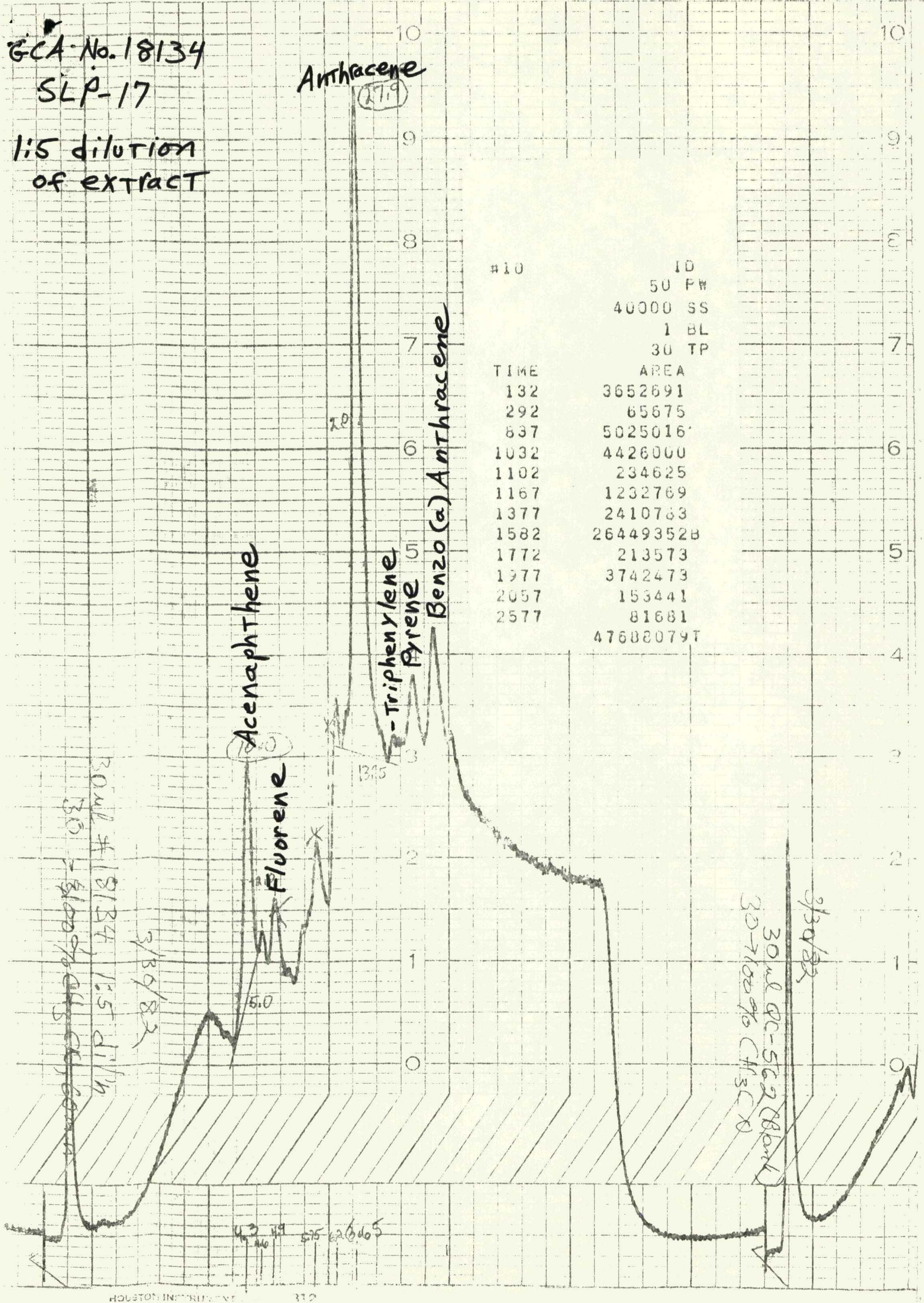
GCA No. 18134
SLP-17



# 8	ID
	50 PW
	40000 SS
	1 BL
	30 TP
TIME	AREA
14	38895
129	164742168
299	232874
394	376101
469	685568
529	497711
564	222210
619	580395
734	393704
2004	[illegible]
2434	[illegible]
2644	[illegible]
2389	160034
3014	46435
3124	7294
3169	21437
3274	124432
3399	117841
3459	30787
3489	26365
[illegible]	[illegible]
[illegible]	[illegible]
[illegible]	[illegible]
	[illegible]

GCA No. 18134
SLP-17

1:5 dilution
of extract

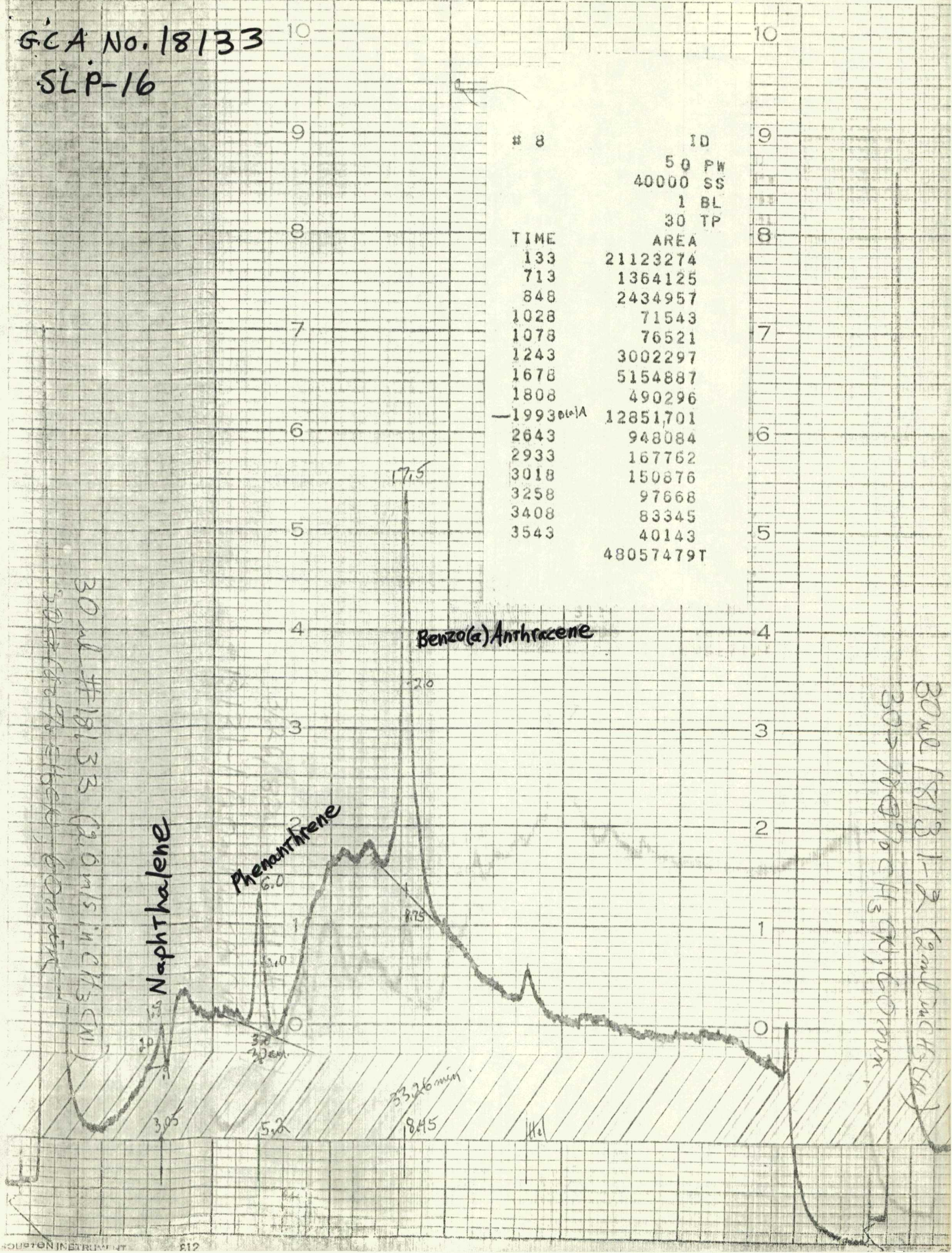


\#10

	ID
	50 PW
	40000 SS
	1 BL
	30 TP
TIME	AREA
132	3652691
292	65675
837	5025016
1032	4426000
1102	234625
1167	1232769
1377	2410763
1582	26449352B
1772	213573
1977	3742473
2057	153441
2577	81681
	47688079T

GCA No. 18133
SLP-16

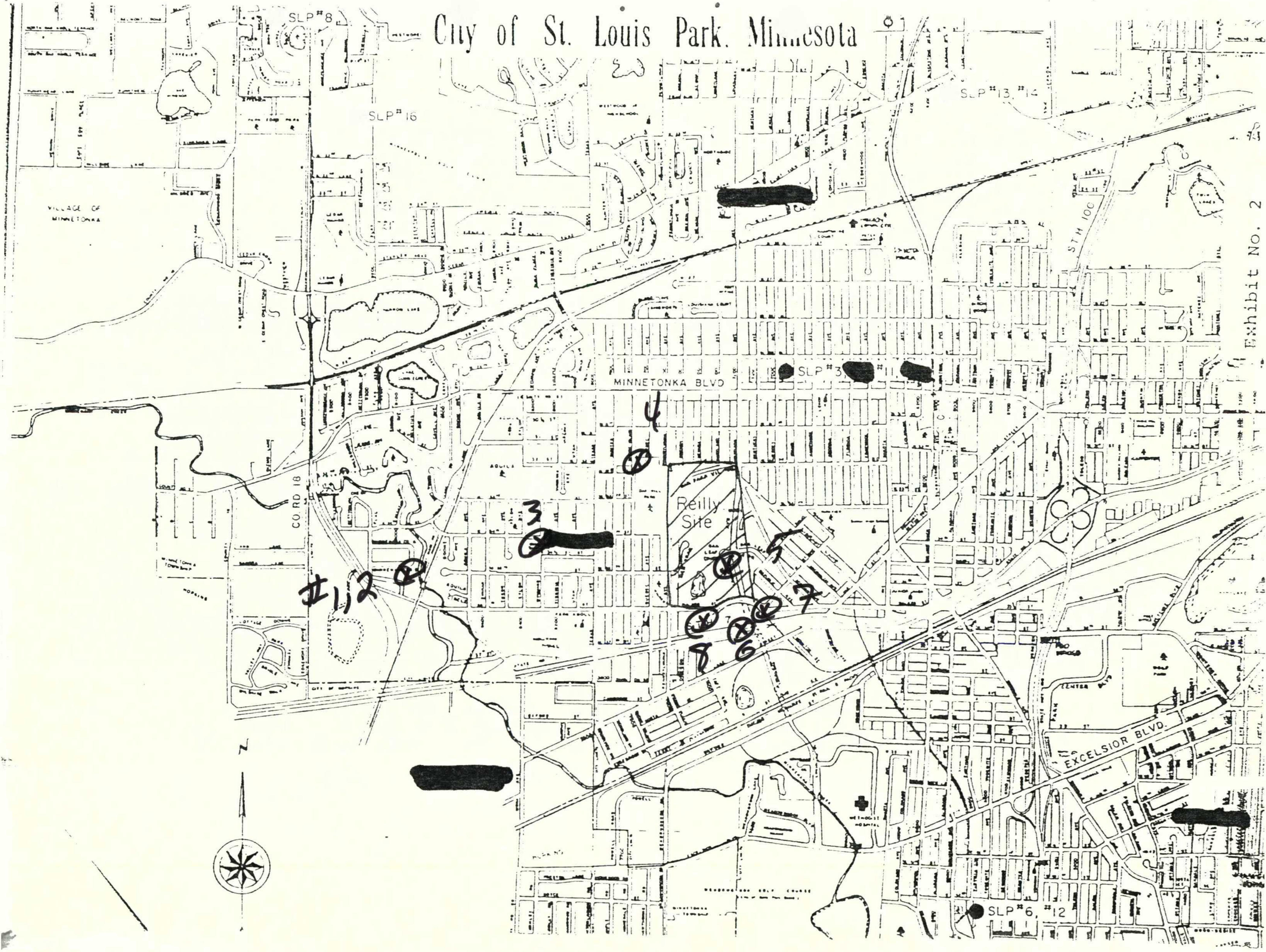
# 8	ID
	50 PW
	40000 SS
	1 BL
	30 TP
TIME	AREA
133	21123274
713	1364125
848	2434957
1028	71543
1078	76521
1243	3002297
1678	5154887
1808	490296
—1993 B(a)A	12851701
2643	948084
2933	167762
3018	150876
3258	97668
3408	83345
3543	40143
	48057479T

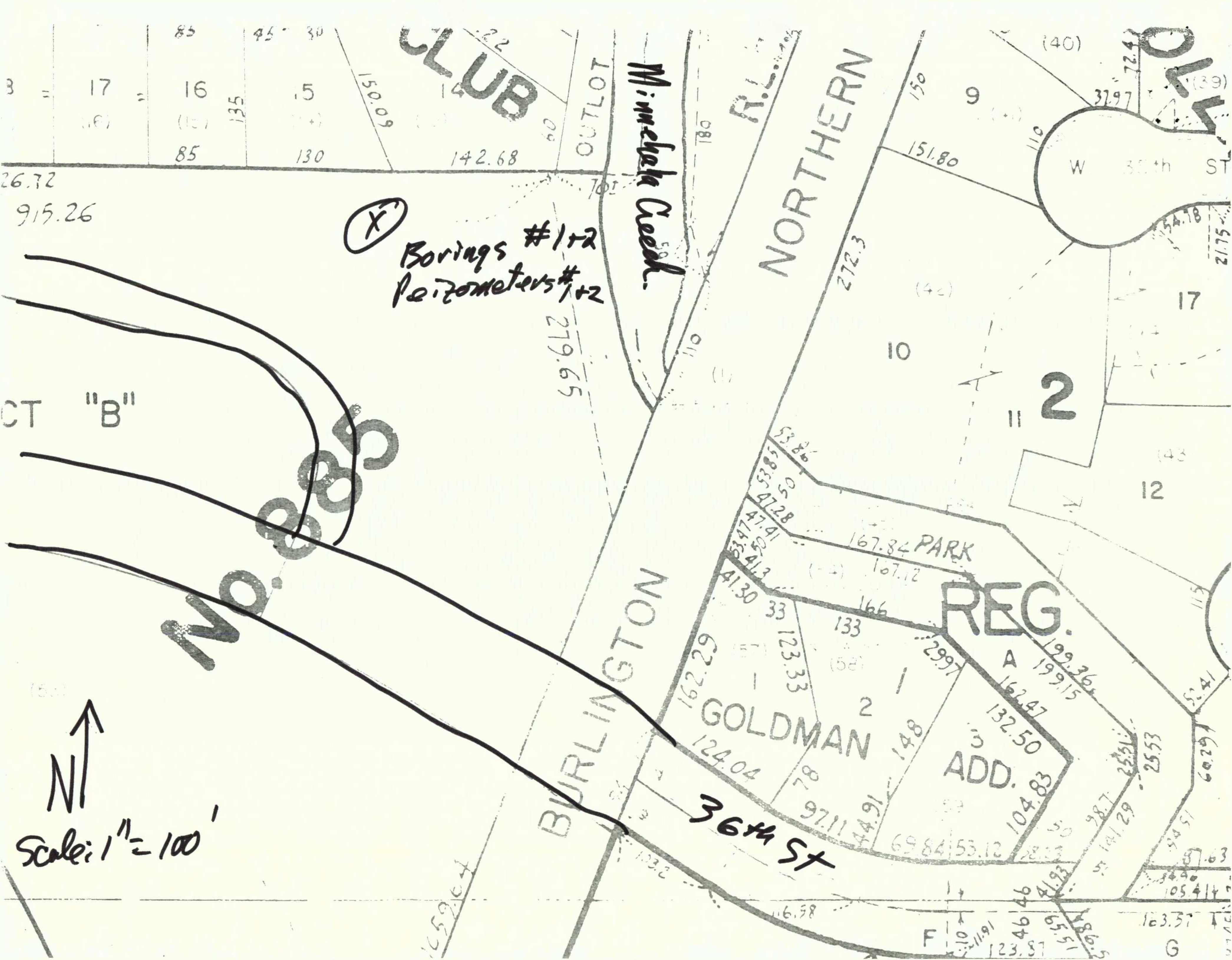


ike kosa ;
, Waste Program
Enforcement

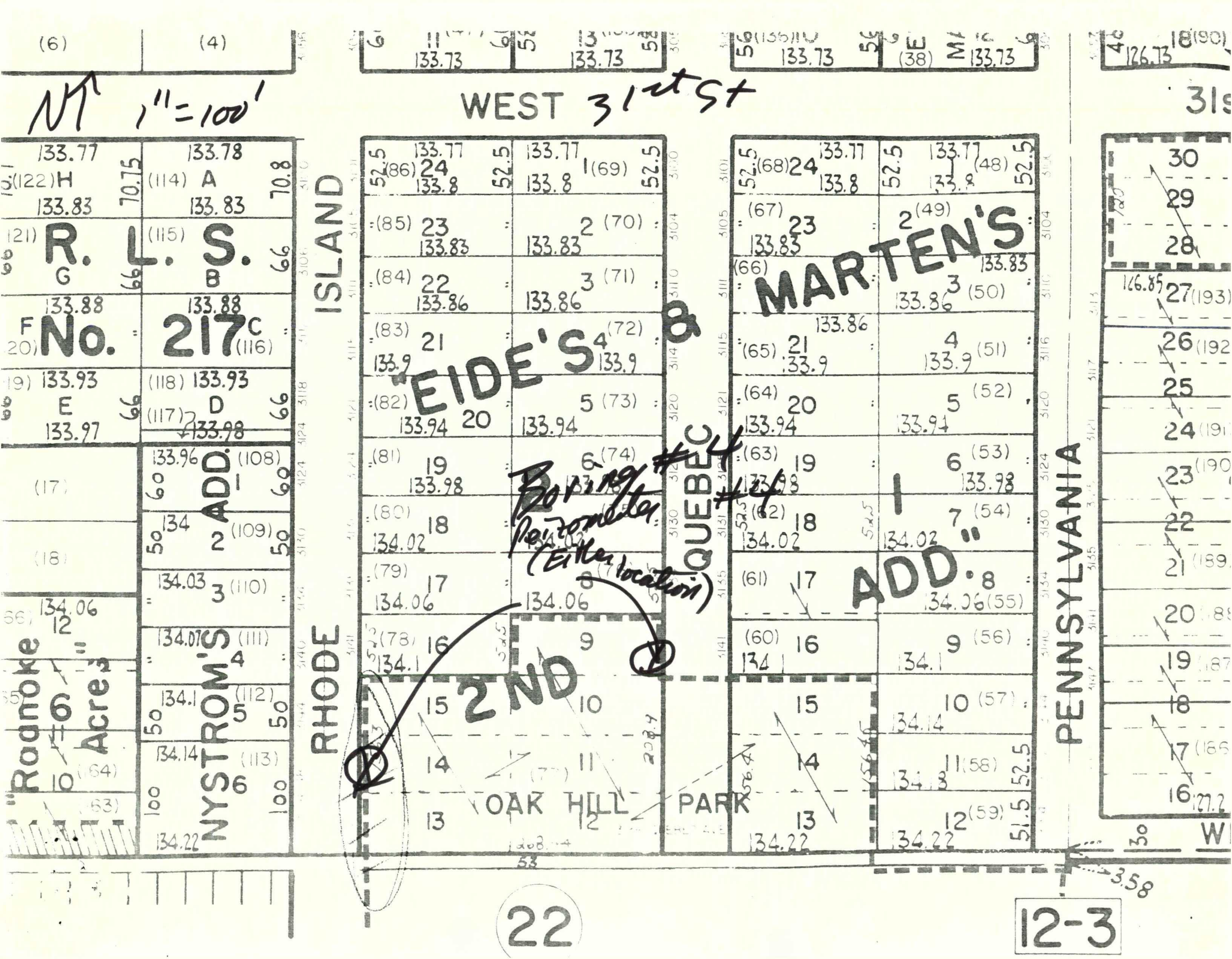
GCA Soils Boring Project
Reilly Tar Site
St. Louis Park, Minnesota

Boring Number	Piezometer Number	USGS Project Number	Location	Detail Map	Purpose
1	1		36th & Minnehaha Creek	Yes	Shake down; uncontaminated peat sample, drift well
2	2		36th & Minnehaha Creek	Yes	Uncontaminated Platteville well; samples of uncontaminated drift soils
3	3		34th & Wyoming near SLP #5	No	Platteville well at edge of known contamination; drift samples near edge of known contamination
4	4		32nd & Rhode Island/ Quebec, Oak Hill Park	Yes	Drift well near area of suspected disposal, previously not investigated
5	5		Near W23, Reilly deep well	No	Drift well to determine contamination of drift near major source of PdC/J contamination
6	--		On Highway 7, west of Louisiana Ave. Extension	Yes	Drift boring to determine effect of highway construction on lacustrian deposits
7	--		Walker Ave. and Louisiana Ave. Extension	Yes	Drift boring to determine northern extent of contamination in major disposal area
8	--		400' west of Boring #7	Yes	"
9	--		(Reserve)		If heavy contamination found in boring #7 or 8, wait til second round. If contamination not found, place near USGS W13


City of St. Louis Park, Minnesota
SLP#8
SLP#16
SLP#13, #14
VILLAGE OF MINNETONKA
STH 100
MINNETONKA BLVD
SLP#3
4
Reilly Site
3
5
#1,2
7
8
6
CO. RD 18
EXCELSIOR BLVD.
N
SLP#6, #12
Exhibit No. 2

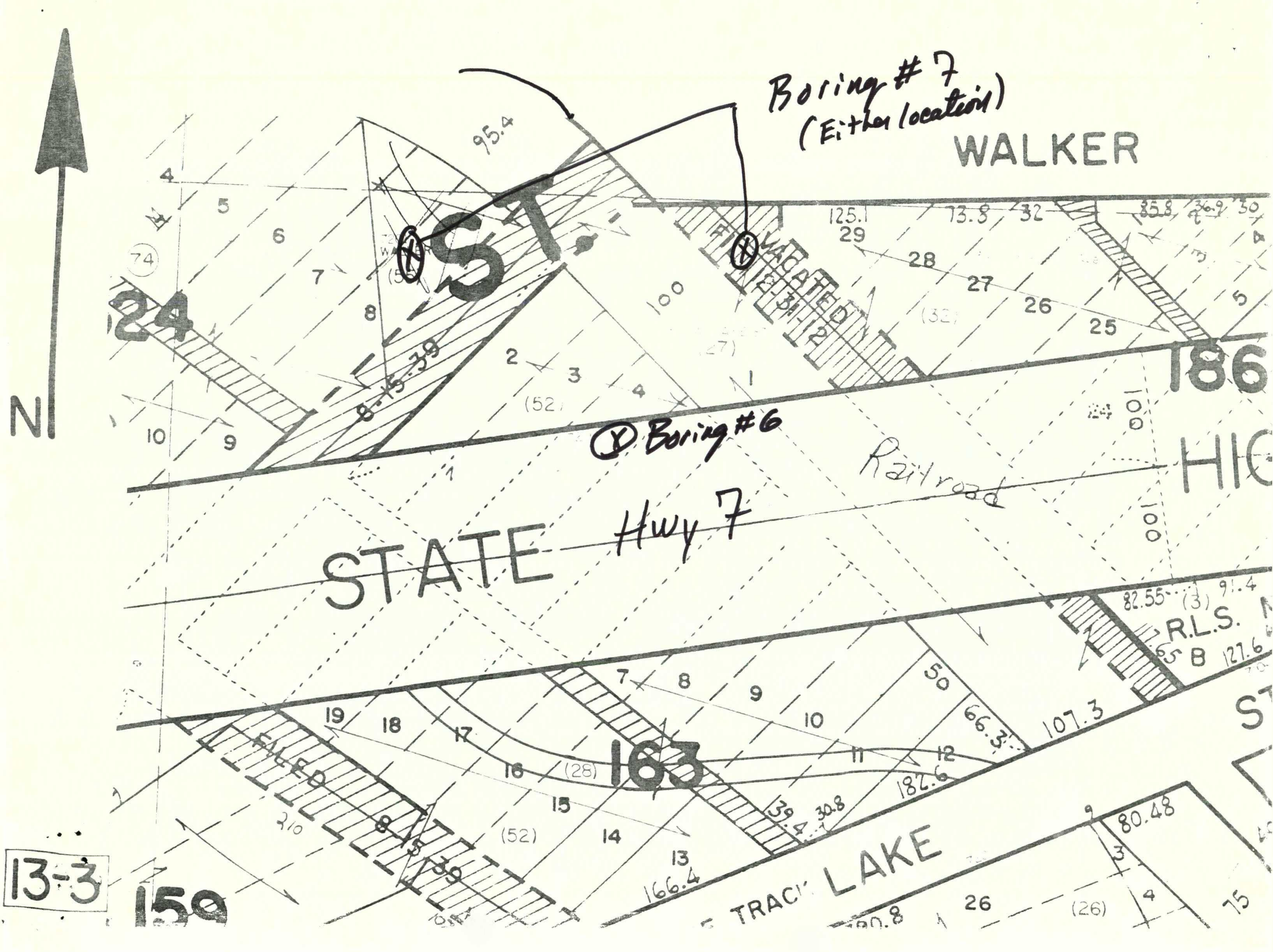


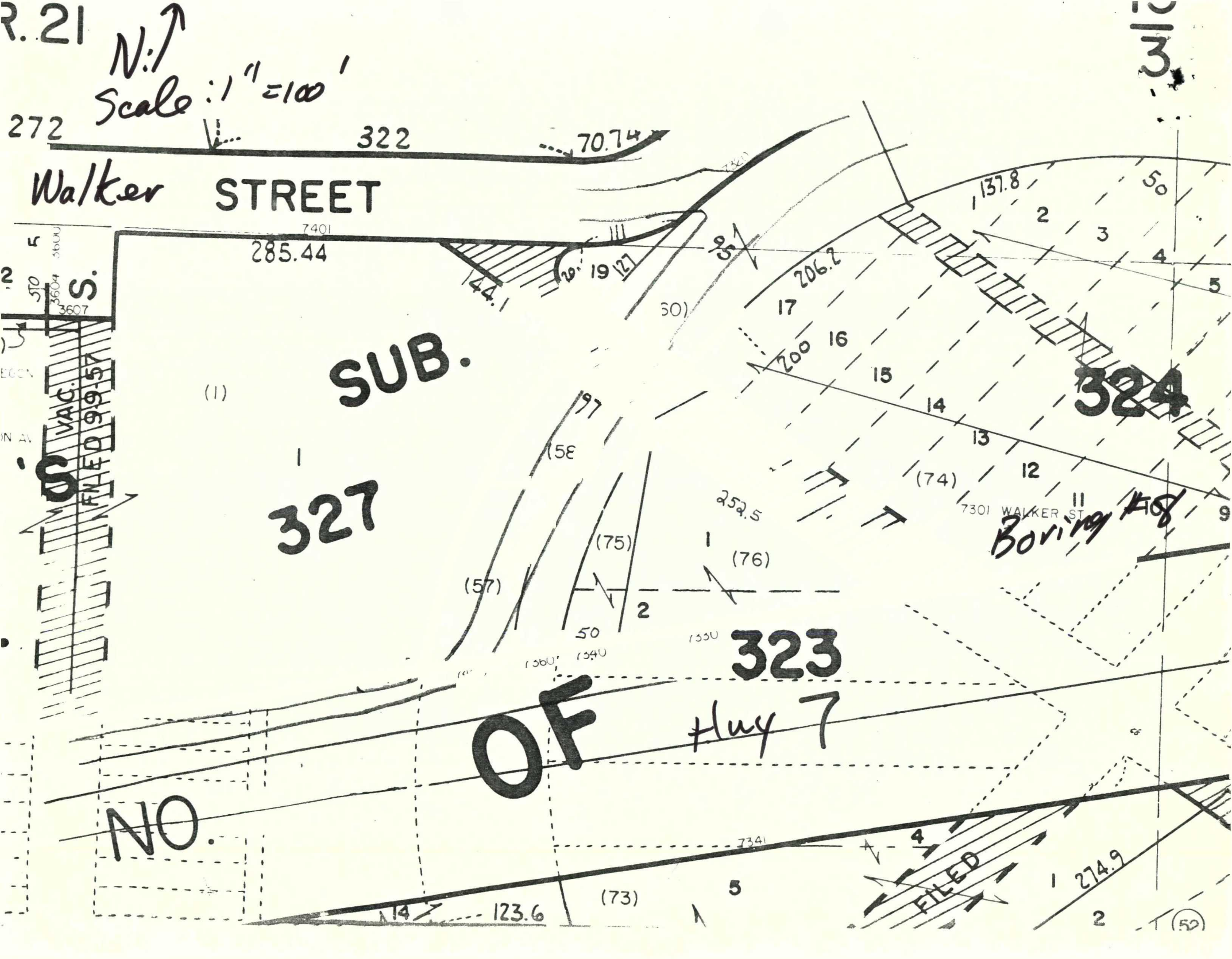
CLUB
OUTLOT
Minnehaha Creek
NORTHERN
BURLINGTON
R.L.
W 36th ST
Borings #1+2
Peizometers #1+2
(X)
CT "B"
No. 885
2
REG.
PARK
GOLDMAN
ADD.
36th St
N
Scale: 1" = 100'



N
1" = 100'
WEST 31st St
ISLAND
RHODE
QUEBEC
PENNSYLVANIA
R. L. S. No. 217
"EIDE'S & MARTEN'S 1 ADD."
2ND ADD.
NYSTROM'S
"Roanoke Acres" 6
OAK HILL PARK
Boring #4
Peizometer #4
(Either location)
22
12-3

SCALE: 1 INCH = 100 FEET





R. 21
N:
Scale: 1" = 100'
3
272
322
70.74
Walker STREET
7401
285.44
144
19
127
50
137.8
50
2
3
4
5
206.2
17
16
200
15
14
13
12
11
9
324
SUB.
(1)
1
327
VAC.
FILED 99.57
(58
(57)
(75)
2
50
252.5
1
(76)
(74)
7301 WALKER ST.
Boring #8
323
OF
Hwy 7
NO.
7341
4
FILED
1
274.9
2
5
(73)
14
123.6
(52)

CROSS REFERENCE LIST OF WATER SAMPLES RECEIVED FOR PAH ANALYSIS

(EPA Contract No. 68-01-6316)
(GCA 1-452-124)

Sampling date	Sample code	GCA Control No.
1/13/82	UM-827	18825
	UM-840	18826
	UM-847	18827
	UM-859	18828
	Ford Dam	18829
1/19/82	Field Blank (1/19/82)	18931
	EFF E	18932
	EFF W	18933
	Ford Dam	18934
	Gray Cloud	18935
	INF	18936
	UM-827	18937
	UM-840	18938
	UM-847	18939
	UM-859	18940
1/21/82	Field Blank (1/21/82)	18977
	EFF E	18978
	EFF W	18979
	INF E	18980
	INF ISCO	18981
1/26/82	Field Blank (1/26/82)	19099
	INF E	19100
	INF E ISCO	19101
	EFF E	19102
	EFF W	19103
1/28/82	Field Blank (1/28/82)	19157
	EFF E II^{o}	19158
	EFF W II^{o}	19159
	INF E I^{o}	19160
	INF I^{o} E ISCO	19161

Project 1-452-124b GCA Control No. 18132

DATA REPORT SHEET
Polynuclear Aromatic Hydrocarbons
EPA Method 610

Sample I.D. SLP 15

Additional Comments

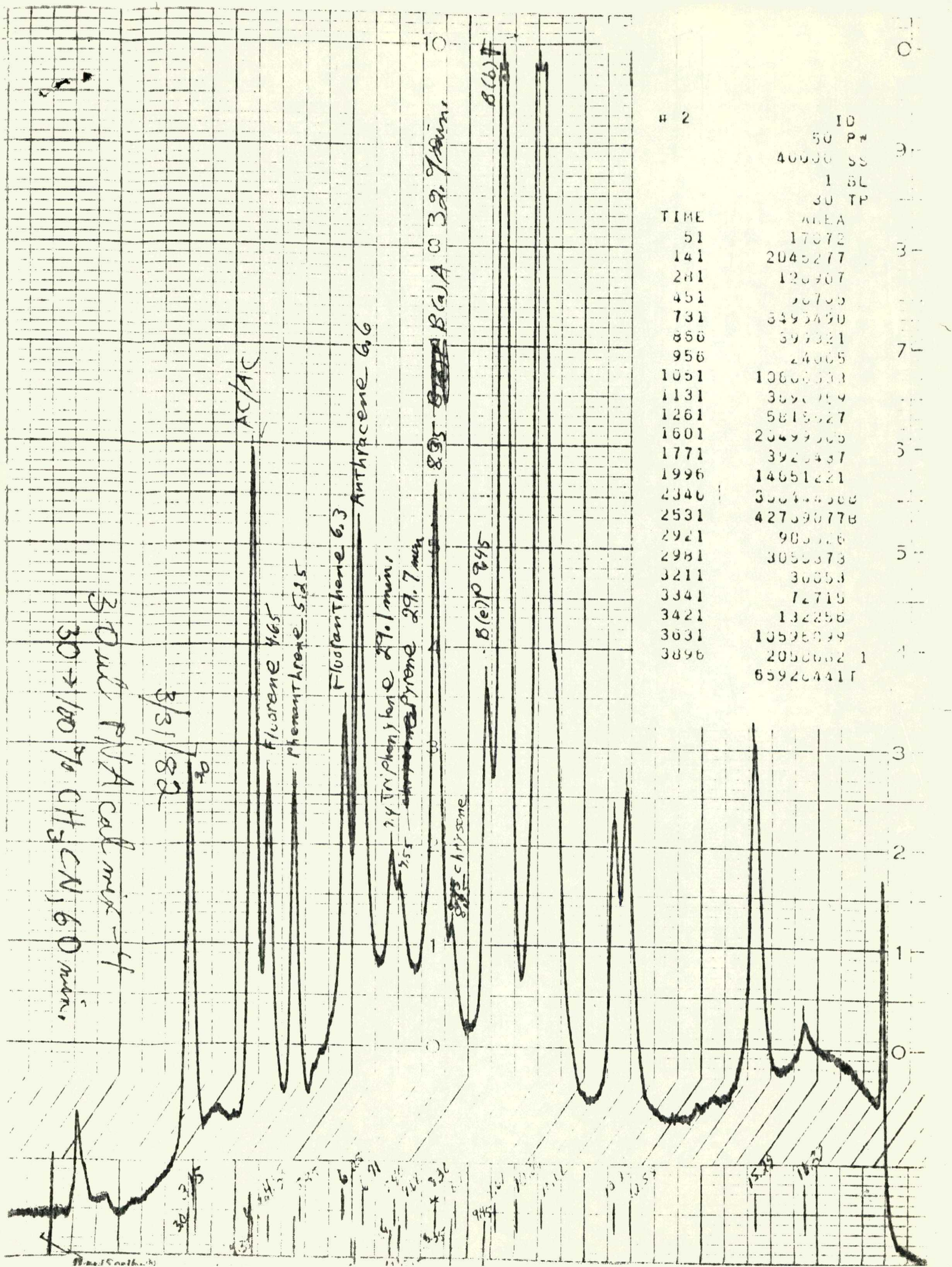
Analyst(s) M. Gardell Checked By R. Robillard

Analysis Date 3/31/82 Report Date 4/13/82

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 57	
Acenaphthene[1]	2,200	
Fluorene	25,000	
Phenanthrene	< 10	
Fluoranthene	20,000	
Anthracene	270	
Triphenylene	86	
Pyrene	< 8	370
Benzo(a)Anthracene	17	
Chrysene	< 2	
Benzo(e)Pyrene	< 5	
Benzo(b)Fluoranthene	< 40	
Benzo(a)Pyrene[2]	< 1	
Benzo(g,h,i)Perylene	< 10	
Dibenzo(a,h)Anthracene	< 5	
Indeno(1,2,3-cd)Pyrene	< 50	

[1] Coelutes with Acenaphthylene--Value calculated on basis of Acenaphthene.

[2] Coelutes with Benzo(k)Fluoranthene--Value calculated on basis of Benzo(a) Pyrene



3/31/82
3 µl PNA cal mix - 4
30→100% CH3CN, 60 min.
AC/AC
Fluorene 4.65
Phenanthrene 5.25
Fluoranthene 6.3
Anthracene 6.6
2,4 Triphenylene 29.1 min.
Pyrene 29.7 min
8.95 B(a)A
32.7 min.
chrysene
B(e)P 9.45
B(b)F
2
ID
50 PW
40000 SS
1 BL
30 TP
TIME AREA
51 17072
141 2045277
281 120907
451 [illegible]
731 3495490
856 399321
956 24005
1051 [illegible]
1131 [illegible]
1261 5815527
1601 [illegible]
1771 [illegible]
1996 14651221
2340 [illegible]
2531 [illegible]
2921 [illegible]
2981 [illegible]
3211 30053
3341 72715
3421 132256
3631 [illegible]
3896 [illegible]
[illegible]

9/22/82
N.

RECD SEP 27 1982

9-22-82

Monsanto

MONSANTO RESEARCH CORPORATION
Dayton Laboratory
1515 Nicholas Road
P. O. Box 8, Station B
Dayton, Ohio 45407
Phone: (513) 268-3411
TWX 810-459-1681

W23 Samples taken as of 9/22/82

22 Wednesday 1982

Mr. John C. Craun
Environmental Research and Technology, Inc.
Porter Building - Tenth Floor
601 Grant Street
Pittsburgh, Pennsylvania 15219

Dear John:

The attached table is a listing of the water samples presently on hand at MRC from OW23.

Sincerely,

MONSANTO RESEARCH CORPORATION

Joseph J. Brooks

Joseph J. Brooks, Ph.D.
Research Group Leader
GC/MS Technology

cc: Paul Rivers/RTC
Ed Schwartzbauer/Dorsey, Windhorst, Hannaford, Whitney * Halladay

408745

St. Louis Park OW23 Water Samples on Hand at MRC (9/20/82)

MRC Log Number	Date	Time	Depth	Quantity	Description
1-82-07-19-06	7/16	9:30	824'	1L	Bailer Sample - water, suspended shale and possible tar within (liquid), green
1-82-07-28-05	7/27	12:00	850'	1L	Bailer Sample - grayish, soupy liquid, watery, some tar odor, gas film on top, some sand
1-82-07-30-01	7/28	15:50	861'	1L	Bailer Sample - soupy, watery-gray liquid, some tar floating on top (film), also some sand and shale
1-82-07-30-01	7/29	9:00	861'	1L	Bailer Sample - soupy, watery-gray material, some sand and pieces of shale within, note tarry film on top
1-82-08-11-02	8/5	9:25	100'	1L	Pump Sample - sample taken at discharge before filter
1-82-08-11-02	8/5	9:28	100'	~0.3L	Pump Sample - sample taken after discharge filter before entering pond.
1-82-08-11-02	8/5	14:30	668.5'	1L	Pump Sample
1-82-08-11-02	8/6	8:23	752.5'	1L	Pump Sample - pH 7.36, 16 min. since pumping began
*1-82-08-11-02	8/7	10:00	804.5'	1L	Pump Sample - sample from 24-hour pumping test at 804.5'
1-82-09-15-03	9/13	12:20	810'	4L	Pump Sample - 24-hour pumping test
1-82-09-15-03	9/13	12:45	810'	4L	Pump Sample - 24-hour pumping test
1-82-09-15-03	9/13	13:15	810'	4L	Pump Sample - 24-hour pumping test
1-82-09-15-03	9/13	14:15	810'	4L	Pump Sample - 24-hour pumping test
1-82-09-15-03	9/13	16:15	810'	4L	Pump Sample - 24-hour pumping test
1-82-09-15-03	9/14	15:00	810'	4L	Pump Sample - 24-hour pumping test
1-82-09-20-02	9/17	16:30	810'	8L	Pump Sample

*Two other samples taken at 804.5' at 08/06/18:00 and 08/07/02:00 were broken during shipment and lost.

9-20-82

405706

9/14/82
N.

545 Indian Mound
Wayzata, Minnesota 55391
(612) 473-4224

September 14, 1982

Mr. Mike Hansel
Regulatory Compliance Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B2
Roseville, Minnesota 55113

Re: St. Louis Park Well Abandonment Program

Dear Mr. Hansel:

Enclosed please find one (1) copy of the results of the pumping test performed on September 6th and 7th (24 hour) as well as the results of the clean-out pumping of September 5, 1982. The results are not corrected for recoveries or extraction efficiency.

The samples are coded as follows:

OW 23 F. MS 0	Well W 23 Formation - Mt. Simon Time into pumping test
OW 23 F. MS 0800	Well W 23 Formation - Mt. Simon Time into pumping test (8 hrs)
OW 23 F. MS 1600	Well W 23 Formation - Mt. Simon Time into pumping test (16 hrs)
OW 23 F. MS 24	Well W 23 Formation - Mt. Simon Time into pumping test (24 hrs)
OW 23 F. Pond 0	Well W 23 Stormwater Pond West of W 23 Grab sample - prior to discharge in pond
OW 23 F. EC 0	Well W 23 Formation - Eau Claire (752.5 ft) Time 0 represents 6.5 minutes after pump turned on

9626726

Mr. Mike Hansel
Page Two
September 14, 1982

OW 23 F.100 9:10	Well W 23 Pump setting - 100 feet Time sample taken - 13 minutes after pump turned on
OW 23 F.FS 0	Well 23 Pump setting - 668.5 feet Time sample taken - 13 minutes after pump turned on

If you have any questions and/or comments please feel free to contact me at 473-4224.

Sincerely,

EUGENE A. HICKOK AND ASSOCIATES

George Boyer

George W. Boyer, P.E.
Vice President

bt

9626-27

The University of Iowa
Iowa City, Iowa 52242

RECEIVED SEP 13 1982

University Hygienic Laboratory
(319) 353-5990

10 September 1982

E.A. Hickok and Associates
545 Indian Mound
Wayzata, MN 55391

Attn: Mr. George Boyer

Dear George:

Attached are the results from the St. Louis Park samples.

The results are not corrected for recoveries or extraction efficiency. If you have any questions contact us.

Sincerely,

Armand F. Lange, Ph.D

Armand F. Lange, Ph.D.
Chief, Organic Analytical Division

mh

cc: Dr. Splinter
Dr. Hahne
Mr. Brewer
Ms. Cain
File

9626728

Q m/e	Compound	% recoveries 1μg/L spike	10μg/L spike
117	2,3-dihydroindene	27	54
115	Indene	36	62
128	Naphthalene	47	74
134	Benzo[b]thiophene	48	79
129	Quinoline	46	110
142	2-methylnaphthalene	50	92
117	Indole	53	103
142	1-methylnaphthalene	50	102
154	1,1'biphenyl	59	103
152	Acenaphthylene	62	108
154	Acenaphthene	73	121
166	Fluorene	80	104
178	Phenanthrene	85	120
178	Anthracene	83	97
179	Acridine	74	120
179	Phenanthridine	75	115
167	Carbazole	115	117
202	Fluoranthene	95	68
202	Pyrene		123
228	Benz[a]anthracene	89	120
228	Chrysene	97	122
252	Benzo[b]fluoranthene	85	108
252	Benzo[k]fluoranthene	72	106
252	Benzo[e]pyrene	84	107
252	Benzo[a]pyrene	82	106
252	Perylene		105
276	Indeno[1,2,3 CD]pyrene	91	90
278	Dibenz[a,h]anthracene	74	103
276	Benzo[g,h,i]perylene	84	110

Q m/e	Compound	SOL BLK µg/L
117	2,3-dihydroindene	<1
115	Indene	<1
128	Naphthalene	<1
134	Benzo[b]thiophene	<1
129	Quinoline	<5
142	2-methylnaphthalene	<1
117	Indole	<1
142	1-methylnaphthalene	<1
154	1,1'biphenyl	<1
152	Acenaphthylene	<1
154	Acenaphthene	<1
166	Fluorene	<1
178	Phenanthrene	<1
178	Anthracene	<1
179	Acridine	<1
179	Phenanthridine	<1
167	Carbazole	<1
202	Fluoranthene	<1
202	Pyrene	<1
228	Benz[a]anthracene	<1
228	Chrysene	<1
252	Benzo[b]fluoranthene	<1
252	Benzo[k]fluoranthene	<1
252	Benzo[e]pyrene	<1
252	Benzo[a]pyrene	<1
252	Perylene	<1
276	Indeno[1,2,3 CD]pyrene	<1
278	Dibenz[a,h]anthracene	<1
276	Benzo[g,h,i]perylene	<1

Q m/e	Compound	OFW BLK µg/L										
117	2,3-dihydroindene	<1										
115	Indene	<1										
128	Naphthalene	<1										
134	Benzo[b]thiophene	<1										
129	Quinoline	<5										
142	2-methylnaphthalene	<1										
117	Indole	<1										
142	1-methylnaphthalene	<1										
154	1,1'biphenyl	<1										
152	Acenaphthylene	<1										
154	Acenaphthene	<1										
166	Fluorene	<1										
178	Phenanthrene	<1										
178	Anthracene	<1										
179	Acridine	<1										
179	Phenanthridine	<1										
167	Carbazole	<1										
202	Fluoranthene	<1										
202	Pyrene	<1										
228	Benz[a]anthracene	<1										
228	Chrysene	<1										
252	Benzo[b]fluoranthene	<1										
252	Benzo[k]fluoranthene	<1										
252	Benzo[e]pyrene	<1										
252	Benzo[a]pyrene	<1										
252	Perylene	<1										
276	Indeno[1,2,3 CD]pyrene	<1										
278	Dibenz[a,h]anthracene	<1										
276	Benzo[g,h,i]perylene	<1										

well 23

Mt. Simon-Hinckley Aquifer

OW 23 F. MS formation

Lab # 2-2778 /4153 0 pumping duration 8-6-82 sampling date

800 = 8hrs

Q m/e	Compound	µg/L
117	2,3-dihydroindene	102
115	Indene	204
128	Naphthalene	1287
134	Benzo[b]thiophene	154
129	Quinoline	<5
142	2-methylnaphthalene	2241
117	Indole	156
142	1-methylnaphthalene	1497
154	1,1'biphenyl	788
152	Acenaphthylene	808
154	Acenaphthene	1628
166	Fluorene	1757
178	Phenanthrene	5249
178	Anthracene	2004
179	Acridine	295
179	Phenanthridine	399
167	Carbazole	3013
202	Fluoranthene	4334
202	Pyrene	3662
228	Benz[a]anthracene	1748
228	Chrysene	1628
252	Benzo[b]fluoranthene	1301
252	Benzo[k]fluoranthene	1028
252	Benzo[e]pyrene	928
252	Benzo[a]pyrene	1498
252	Perylene	506
276	Indeno[1,2,3 CD]pyrene	1612
278	Dibenz[a,h]anthracene	588
276	Benzo[g,h,i]perylene	944

9626732

OW 23 Formation MS

Lab # 2-2776 /4154 0800 8-6-82

Q m/e	Compound	μg/L
117	2,3-dihydroindene	12
115	Indene	32
128	Naphthalene	71
134	Benzo[b]thiophene	9
129	Quinoline	<5
142	2-methylnaphthalene	47
117	Indole	<1*
142	1-methylnaphthalene	49
154	1,1'biphenyl	9
152	Acenaphthylene	12
154	Acenaphthene	26
166	Fluorene	26
178	Phenanthrene	29
178	Anthracene	7
179	Acridine	<1*
179	Phenanthridine	<1*
167	Carbazole	7
202	Fluoranthene	14
202	Pyrene	12
228	Benz[a]anthracene	6
228	Chrysene	4
252	Benzo[b]fluoranthene	2
252	Benzo[k]fluoranthene	1
252	Benzo[e]pyrene	1
252	Benzo[a]pyrene	2
252	Perylene	<1*
276	Indeno[1,2,3 CD]pyrene	1
278	Dibenz[a,h]anthracene	<1*
276	Benzo[g,h,i]perylene	1

* compound present, but below quantitation limits

Q m/e	Compound	µg/L	Lab # 2-2777	/4155	OW 23 1600	F. MS 8-7-82
117	2,3-dihydroindene	5				
115	Indene	14				
128	Naphthalene	52				
134	Benzo[b]thiophene	5				
129	Quinoline	<5				
142	2-methylnaphthalene	12				
11/	Indole	<1*				
142	1-methylnaphthalene	16				
154	1,1'biphenyl	3				
152	Acenaphthylene	8				
154	Acenaphthene	9				
166	Fluorene	17				
.78	Phenanthrene	16				
178	Anthracene	3				
179	Acridine	<1*				
179	Phenanthridine	<1*				
167	Carbazole	4				
202	Fluoranthene	7				
202	Pyrene	5				
228	Benz[a]anthracene	<1*				
228	Chrysene	<1*				
252	Benzo[b]fluoranthene	<1*				
252	Benzo[k]fluoranthene	<1*				
252	Benzo[e]pyrene	<1*				
252	Benzo[a]pyrene	<1*				
252	Perylene	<1*				
276	Indeno[1,2,3 CD]pyrene	<1*				
278	Dibenz[a,h]anthracene	<1*				
276	Benzo[g,h,i]perylene	<1*				

* compound present, but below quantitation limits

9626-34

OW 23 F. MS

Lab # 2-2779 /4156 24 8-7-82

Q m/e	Compound	µg/L
117	2,3-dihydroindene	12
115	Indene	31
128	Naphthalene	78
134	Benzo[b]thiophene	10
129	Quinoline	<5
142	2-methylnaphthalene	25
117	Indole	1
142	1-methylnaphthalene	27
154	1,1'biphenyl	8
152	Acenaphthylene	12
154	Acenaphthene	24
166	Fluorene	20
178	Phenanthrene	22
178	Anthracene	4
179	Acridine	5
179	Phenanthridine	<1*
167	Carbazole	7
202	Fluoranthene	8
202	Pyrene	7
228	Benz[a]anthracene	1
228	Chrysene	<1*
252	Benzo[b]fluoranthene	<1*
252	Benzo[k]fluoranthene	<1*
252	Benzo[e]pyrene	<1*
252	Benzo[a]pyrene	1
252	Perylene	<1*
276	Indeno[1,2,3 CD]pyrene	<1*
278	Dibenz[a,h]anthracene	<1*
276	Benzo[g,h,i]perylene	<1*

* compound present, but below quantitation limits

OW 23 F. Pond

Lab # 2-2781 /4158 0 8-5-82

Q m/e	Compound	µ g/L
117	2,3-dihydroindene	<1
115	Indene	<1
128	Naphthalene	<1
134	Benzo[b]thiophene	<1
129	Quinoline	<5
142	2-methylnaphthalene	<1
117	Indole	<1
142	1-methylnaphthalene	<1
154	1,1'biphenyl	<1
152	Acenaphthylene	<1
154	Acenaphthene	<1
166	Fluorene	<1
178	Phenanthrene	<1
178	Anthracene	<1
179	Acridine	<1
179	Phenanthridine	<1
167	Carbazole	<1
202	Fluoranthene	<1
202	Pyrene	<1
228	Benz[a]anthracene	<1
228	Chrysene	<1
252	Benzo[b]fluoranthene	<1
252	Benzo[k]fluoranthene	<1
252	Benzo[e]pyrene	<1
252	Benzo[a]pyrene	<1
252	Perylene	<1
276	Indeno[1,2,3 CD]pyrene	<1
278	Dibenz[a,h]anthracene	<1
276	Benzo[g,h,i]perylene	<1

OW 23 F. EC

Q m/e	Compound	µg/L	Lab # 2-2780	/4157	0	8-6-82
117	2,3-dihydroindene	15				
115	Indene	16				
128	Naphthalene	6				
134	Benzo[b]thiophene	7				
129	Quinoline	<5				
142	2-methylnaphthalene	17				
117	Indole	2				
142	1-methylnaphthalene	53				
154	1,1'biphenyl	16				
152	Acenaphthylene	22				
154	Acenaphthene	41				
166	Fluorene	62				
˙78	Phenanthrene	114				
178	Anthracene	37				
179	Acridine	5				
179	Phenanthridine	1				
167	Carbazole	3				
202	Fluoranthene	68				
202	Pyrene	52				
228	Benz[a]anthracene	21				
228	Chrysene	19				
252	Benzo[b]fluoranthene	15				
252	Benzo[k]fluoranthene	11				
252	Benzo[e]pyrene	11				
252	Benzo[a]pyrene	16				
252	Perylene	5				
276	Indeno[1,2,3 CD]pyrene	15				
278	Dibenz[a,h]anthracene	5				
276	Benzo[g,h,i]perylene	17				

9626737

OW 23 F. 100'

Lab # 2-2782 /4159 9:10 8-5-82

Q m/e	Compound	µg/L
117	2,3-dihydroindene	16
115	Indene	17
128	Naphthalene	11
134	Benzo[b]thiophene	10
129	Quinoline	<5
142	2-methylnaphthalene	18
117	Indole	2
142	1-methylnaphthalene	233
154	1,1'biphenyl	23
152	Acenaphthylene	34
154	Acenaphthene	326
166	Fluorene	263
178	Phenanthrene	659
178	Anthracene	169
179	Acridine	22
179	Phenanthridine	11
167	Carbazole	3
202	Fluoranthene	428
202	Pyrene	291
228	Benz[a]anthracene	152
228	Chrysene	122
252	Benzo[b]fluoranthene	122
252	Benzo[k]fluoranthene	121
252	Benzo[e]pyrene	111
252	Benzo[a]pyrene	122
252	Perylene	37
276	Indeno[1,2,3 CD]pyrene	72
278	Dibenz[a,h]anthracene	26
276	Benzo[g,h,i]perylene	68

9626738

OW 23 F. FS

Lab # 2-2783 /4160 0 8-5-82

Q m/e	Compound	µg/L
117	2,3-dihydroindene	14
115	Indene	21
128	Naphthalene	72
134	Benzo[b]thiophene	13
129	Quinoline	<5
142	2-methylnaphthalene	40
117	Indole	<1*
142	1-methylnaphthalene	42
154	1,1'biphenyl	19
152	Acenaphthylene	22
154	Acenaphthene	31
166	Fluorene	36
178	Phenanthrene	85
178	Anthracene	16
179	Acridine	5
179	Phenanthridine	<1*
167	Carbazole	12
202	Fluoranthene	40
202	Pyrene	26
228	Benz[a]anthracene	16
228	Chrysene	12
252	Benzo[b]fluoranthene	11
252	Benzo[k]fluoranthene	7
252	Benzo[e]pyrene	7
252	Benzo[a]pyrene	12
252	Perylene	3
276	Indeno[1,2,3 CD]pyrene	3
278	Dibenz[a,h]anthracene	1
276	Benzo[g,h,i]perylene	3

* Compound present, but below quantitation limits

96267[illegible]9

UNIVERSITY HYGIENIC LABORATORY

Sample	2-Fluoronaphthalene % recovery	D_{12} Chrysene % recovery
2-2776	58	149
2-2777	56	103
2-2779	59	115
2-2780	72	73
2-2781	37	45
2-2783	64	101
SOL BLK	57	129
$\bar{X}$	57.6	102.1
S. DEV	10.6	34.6

9626740

9/2/82
N.

INTER OFFICE CORRESPONDENCE

REILLY TAR & CHEMICAL CORPORATION

ST. LOUIS PARK TRIAL PREPARATION DOCUMENT

TO: Mr. C. F. Lesher - Main Office   OFFICE: Laboratory

FROM: William Roder   DATE: September 2, 1982

SUBJECT: SLP - WELL 23   cc: Dr. T. D. Bailey - Lab
Mr. R. Polack - MO
Dr. P. Rivers

The analysis of the tarry scrappings from the bailer and drill bit used in the exploration of W-23 gave the following results:

Sample taken on June 29, 1982
Depth 630-645 ft.

Elemental Analysis

	Tarry Scrapping	CH_2Cl_2 Extract of Tar Scrappings	74°C S.P. pitch from distillation of CH_2Cl_2 Extract
% C	47.76%	88.35%	87.09%
% H	4.45	5.98	5.26
% N	0.36	0.48	0.66
% S	5.30	1.42	1.63
% O	20.94	2.27	2.35
Atomic C/H	0.893	1.230	1.380
Atomic H/C	1.119	0.813	0.725
IR Index	-	0.912	0.720
fa	-	0.897	

Solvent Fractionation of the Tarry Scrappings

Normal heptane Insoluble	51.60%
CH_2Cl_2 Insoluble	48.50
$CDCl_2$ Insoluble	38.87
Xylene Insoluble	37.90
Quinoline Insoluble	37.65
Ash	33.50

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NOV 1982
ERT

NHI - XI = 51.60% - 37.90% = 13.7%
XI - QI = 37.90% - 37.65 = 0.25%

Distillation of the Tarry Scrappings

		IR Index	fa
1st drop 98°C			
0-170°C	12.66% H_2O 3.03% oil	1.234	0.780
170-210	1.95	1.161	0.832
210-235	2.06	1.005	0.831
235-270	6.39	1.048	0.809
270-282	4.76	1.039	0.791
Lig Residue	3.35	0.569	
Char Residue	60.93		
	95.3%		

off gasing occurred from 98 to 260°C - Decomposition Loss 4.87%.

106301

C-102AT-P

INTER OFFICE CORRESPONDENCE

REILLY TAR & CHEMICAL CORPORATION

ST. LOUIS PARK TRIAL PREPARATION DOCUMENT

Mr. C. F. Lesher
Page 2
September 2, 1982 - SLP - WELL 23

G. C. analysis of the distillate fractions are tabulated in Table I attached.

Distillation of the CH_2Cl_2 Extractables

		IR Index	fa
0-170°	1.56	3.42	0.897
170-210	0.42	3.54	0.782
210-235	1.15	1.55	0.807
235-270	7.19	1.58	0.810
270-315	7.40	1.21	0.830
315-355	16.35	1.14	0.852
Residue	61.46	0.720	0.878

S.P. of Residue (R & B) = 74°C
Vapor Loss decomposition = 4.47%

G. C. Analysis of the CH_2Cl extractables, plus the distillate fractions of the CH_2Cl_2 extractables are tabulated in table II.

Very truly yours,

Wm Roder
Wm. Roder

WR/jr
attchmt.

106302

ST. LOUIS PARK TRIAL PREPARATION DOCUMENT
G. C. Analysis of Distillate tion

-3- 4.87 gm loss
plus 12.66 gm H_2O
60.93 gm ch
100.08 gm

Table I

12' W98 column

	0-170°C		170-210		210-235		235-270		270-282		Residue Liq.		Total g	
wt. of fraction g	3.03 oil		1.95		2.06		6.39		4.76		3.35		21.54	
	%	grams	%	grams	%	grams	%	grams	%	grams	%	grams		%
Indane	-	-	-	-	0.62	0.01	0.70	0.04	-	-	-	-	0.05	0.23
Naphthalene	10.39	0.31	5.70	0.11	4.94	0.10	5.09	0.33	0.63	0.03			0.88	4.09
Methyl Naphthalene	27.24	0.83	16.08	0.31	13.99	0.29	24.57	1.57	9.15	0.44			3.44	15.97
dimethyl Naphthalene	3.62	0.11	4.10	0.08	4.52	0.09	6.69	0.43	7.54	0.36			1.07	4.97
Acenaphthene	5.35	0.16	4.49	0.09	4.95	0.10	7.98	0.51	7.75	0.37			1.23	5.71
fluorene	4.02	0.12	3.57	0.07	6.01	0.12	5.07	0.33	12.58	0.60			1.24	5.76
Phenanthrene & Anthracene	10.15	0.31	14.56	0.28	13.68	0.28	12.22	0.78	24.16	1.15	19.72	0.66	3.46	16.06
fluoranthene	3.63	0.11	7.63	0.15	7.47	0.15	3.62	0.23	4.06	0.19	17.87	0.60	1.43	6.64
pyrene	3.57	0.11	7.95	0.16	7.27	0.15	3.74	0.24	3.73	0.18	17.79	0.60	1.44	6.69
Chrysene	1.97	0.06	6.02	0.12	5.25	0.11	1.62	0.10	1.14	0.05	9.38	0.31	0.75	3.48
	67.77 ←	2.12	66.67	1.30	67.96	1.40	71.36	4.56	70.82	3.37	64.18 ←	2.17	14.11	69.60

1.5% BMBT Liquid Crystal

	0-170°C		170-210		210-235		235-270		270-282		Residue Liq.		Total g	
wt. of fraction g	3.03g	oil	1.95		2.06		6.39		4.76		3.35		21.54	
Indane														
Naphthalene														
methyl naphthalene														
dimethyl naphthalene														
acenaphthane	1.77	0.05	1.57	0.03	1.24	0.03	3.90	0.25	2.23	0.11			0.47	2.18
fluorene	2.01	0.06	1.51	0.03	1.13	0.02	2.95	0.19	5.01	0.24	0.06	-	0.54	2.51
phenanthrene	8.13	0.25	8.89	0.17	6.58	0.14	10.66	0.68	21.59	1.03	15.69	0.53	2.80	13.00
anthracene	3.02	0.09	2.98	0.06	2.24	0.05	3.13	0.20	6.36	0.3	7.40	0.23	0.93	4.32
carbazole	-	-	-	-	-	-								
fluoranthene	3.82	0.12	5.86	0.11	4.16	0.09	4.24	0.27	4.95	0.24	18.45	0.62	1.45	6.73
pyrene	3.57	0.11	5.62	0.11	4.06	0.08	3.80	0.24	3.83	0.18	17.45	0.58	1.30	6.09
Chrysene	1.69	0.05	4.59	0.09	2.15	0.04	1.81	0.12	1.33	0.05	6.01	0.20	0.56	2.60
	24.09 ←	0.73	30.7[illegible]	0.60	21.84	0.45	30.52	1.95	45.38	2.16	64.49 ←	2.16	8.05 →	37.37

C. Analysis of the CH_2Cl_2 Ext :ables

Table II

12' W-98

	CH_2Cl_2 Extract	60-170°C		170-210		210-235		235-270		270-315		315-355		Residue		Total gram
wt. of fraction g.		1.56g		0.42g		1.15		7.19		7.40		16.35		61.46		
		%	grams	%	grams	%	grams	%	grams	%	grams	%	grams	%	grams	
Indane	<.01%	1.7	0.03	1.5	0.01	1.40	0.02	0.14	0.01	.01	-					0.07
Naphthalene	2.45	18.64	0.29	16.86	0.07	19.16	0.22	15.57	1.12	3.28	0.24	0.21	0.03			1.97
Methyl naphthalene	4.48	14.55	0.23	22.43	0.09	19.22	0.22	25.15	1.81	12.47	0.92	1.53	0.25			3.52
Dimethyl naphthalene	3.37	10.85	0.17	6.45	0.03	4.17	0.05	7.91	0.57	10.83	0.80	4.84	0.79			2.41
Acenapththene	3.23	8.68	0.14	9.01	0.04	3.65	0.04	6.68	0.48	9.68	0.72	4.64	0.75			2.18
fluorene	4.79	3.62	0.06	2.46	0.01	1.96	0.02	3.79	0.27	11.12	0.82	5.44	0.89			2.07
phenanthrene & anthracene	14.68	2.46	0.04	2.50	0.01	3.57	0.04	5.61	0.40	10.90	0.81	26.40	4.30	6.74	4.14	9.74
fluoranthene	8.43	0.26	0.01	0.67	0.01	0.85	0.01	0.70	0.05	2.25	0.17	6.13	1.0	13.08	8.03	9.28
pyrene	7.86	0.18	0.01	0.70	0.01	0.57	0.01	0.54	0.05	1.98	0.15	5.57	0.91	12.18	7.48	8.61
Chrysene	6.21	-								0.38	0.03	1.74	0.28	12.47	7.66	7.97

1.5% BMBT Liquid Crystal

	CH_2Cl_2 Extract	60-170°C		170-210		210-235		235-270		270-315		315-355		Residue		Total gram
Acenaphthene	-									3.81	0.28	3.24	0.53			0.81
Fluorene	1.04					0.77	0.01	1.74	0.13	3.43	0.25	2.88	0.47			0.86
phenanthrene	6.57	NOT ANALYZED DUE TO LACK OF SUFFICIENT SAMPLE				2.44	0.03	5.02	0.36	9.43	0.70	18.90	3.09	1.52	0.93	5.11
anthracene	1.42					0.51	0.01	1.22	0.09	1.68	0.12	5.09	0.83	0.45	0.28	1.33
carbazole	-															
Fluoranthene	3.93					0.28	-	1.08	0.08	1.85	0.14	5.24	0.86	3.53	2.17	3.25
pyrene	3.95					0.05	-	0.69	0.05	1.19	0.09	3.88	0.63	3.61	2.22	2.99
Chrysene	1.66					0.04	-	0.02	-	0.04	-	0.67	0.11	2.15	1.32	1.43

8-17-82

RECD AUG 19 1982 N.

MONSANTO RESEARCH CORPORATION

Inter-Office Correspondence

From LOCATION : B. M. Hughes, Dayton Laboratory
(513) 268-3411 (Ext. 436, 409, 209)

cc: William Gregg/ERT
Jerry R. Rick/SEC
J. J. Brooks/MRC
P. M. Rivers/RTCC

DATE : 17 August 1982

SUBJECT : Analysis Request Forms Received - 215.45718

REFERENCE : U.S.A. v. Reilly Tar & Chemical Corporation

Field Logs/Chain-of-custody of samples submitted to Reilly/MRC
7/13 - 8/10/82
W23

TO : Edward J. Schwartzbauer
Dorsey, Windhorst, Hannaford, Whitney, & Hallada
2200 First Bank Place East
Minneapolis, Minnesota 55402

Enclosed are copies of analytical request forms which have been submitted for the analysis of samples received in conjunction with the project referenced above. MRC has assigned a unique log number for each set of samples and has outlined the requested analyses on the enclosed analytical request forms. If any incorrect information is included on the enclosed forms, please notify me immediately.

B. M. Hughes

B. M. Hughes

Note: Three sludge samples and 2 water samples have been received broken. The three sludge samples were of such a consistency that they were transferred to alternate sample bottles. However, the two water samples were lost due to breakage. Breakage will be minimized if MRC's shipping kits are used, or the bottles are individually wrapped with bubble pack.

ANALYSIS REQUEST | DATE 7/13/82 | LOG NO. 1-82-07-13-03

REPORT RESULTS TO**
FILES / KULIK
Brooks

ONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** Reilly TAR & Chem.

CHARGE NO.** 215.45718

AMPLE DESCRIPTION   NUMBER OF BOTTLES: 1   NUMBER OF SAMPLES ** 1

Reilly TAR   Depth 780'
7/12/8:30
OW 23/ST. Louis Park, MN
Bailer sample

Original Chain of Custody to Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST TO
FILES
Brooks
Gridley

SAMPLES FOR:
Brooks

SAMPLE LOCATION
1-21
FREEZER

REQUIRED ANALYSIS**

GC/MS Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ____________

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME
→ B.M. Hughes		

REQUIRED QA/QC

4118112

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE   ☐ DISCARD   ☐ RETURN   HOLD FOR ☐ 30 DAYS   ☐ 60 DAYS   Hold OTH

SAMPLE TRANSMITTAL LETTER

Client REILLY TAR & CHEM Project Title REPUBLIC TAR + CHEM ~~[illegible]~~ REILLY TAR ' ST. LOUIS PARK, MN (OW23)

Date Shipped 7-12-82 Shipped by Soil Exploration Comp. ~~[illegible]~~, Ross / Olmen

Shipped From Soil Exp. Comp. 662 Cromwell Ave ST. PAUL, MN 55114

Shipped To Monsanto Attention of JOE Bracks

Additional Shipping Information or Comments contains Dry Ice.

Sample Description Code	COMMENTS:
~~[illegible]~~	
REILLY TAR	
OW 23 / ST LOUIS PARK MN	TARRY RUNNY LIQUID
(7-12/8:30)	SOME PIECES OF SHALE
DEPTH → 780'	FROM BAILER ~~[illegible]~~ @ 780'

Samples Received by Alan A. Ford "seal" intact.

Date Samples Received 7/13/82 10:30 Am.

Return Letter Received by Contract Laboratory ______ Date ______

MRC-QA #001T
061082lh

403013

ANALYSIS REQUEST | DATE 7/15/82 | LOG NO. 1-82-07-15-01

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** Reilly TAR

CHARGE NO.** 215.45718

REPORT RESULTS TO** FILES/KULIK
Gridley
Brooks

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 1 NUMBER OF SAMPLES ** 1

Run #: 7-13-14:75 Depth 801'
Sample Location: OW 23 St Louis PARK MN.
Type: Bailer sample

SAMPLE WAS RECEIVED WITH JAR-CONTAINER BROKEN.

Transferred sample and original label to another bottle. Original Chain of Custody to Gridley

RECORDED BY: a Ford

ANALYSIS REQUEST TO: FILES
Gridley
Brooks

SAMPLES FOR: Brooks

SAMPLE LOCATION
1-21
FREEZER

REQUIRED ANALYSIS**

GC/MS Hold Analysis.

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ____________

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME
BM Hughes		

REQUIRED QA/QC

~~118[illegible]~~

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OTH

ANALYSIS REQUEST ORIGINATOR

cc: B. M. Hughes
D. E. Sharp

To B. M. Hughes,

Concerning Memo Requested:

The sample which you have an aliquot of is labeled: Job: Reilly Depth=574
#: 6-11-1021
Location: DW-23
Type: Core from Well
Date: 6-11-82

This is the sample which you found the bottle broken after unsealing it from its bag. The sample has been transferred to another bottle and the original label was taped onto it. All other Reilly Tar samples have been taken out of their bags on your request and checked for breakage - none other was found broken. Labels on other samples were taken from bag and taped directly on bottles where needed (not already duplicated).

Please be careful with the sample which was found broken and transferred, as there are glass fragments in the sample from breakage.

Al Ford - Lab 21

SAMPLE TRANSMITTAL LETTER

Client Monsanto (Reilly TAR) Project Title REILLY TAR + CHEM ST. LOUIS PARK

Date Shipped 7-14-82 Shipped by Ross L. Ohman (Soil exploration comp

Shipped From Soil Exploration Co. 662 Cromwell Ave St Paul MN

Shipped To Monsanto Research Corp. 1515 Nicholas Rd. Dayton Ohio Attention of JOE Brooks

Additional Shipping Information or Comments → FROZEN SAMPLE (7-13-82)

NOTE DRY ICE

Sample Description Code	COMMENTS:
~~Comments~~	
7/13/14:75	BLACK TARRY WATERY LIQUID
DEPTH → 80'	SOME PIECES OF SHALE
	BAILER SAMPLE.

Samples Received by Alan H. Ford "seal" intact - sample broken.

Date Samples Received 7/15/82

Return Letter Received by Contract Laboratory ____________ Date ______

MRC-QA #001T
061082lh

408016

ANALYSIS REQUEST | DATE 7/28/82 | LOG NO. 1-82-07-28-05

REPORT RESULTS TO** FILES/KULIK Gridley Brooks

ONSANTO RESEARCH CORPORATION DAYTON LABORATORY | REQUESTER** Reilly TAR/SOIL EXPLORATION | CHARGE NO.** 215,45718

PLE DESCRIPTION NUMBER OF BOTTLES: 1 NUMBER OF SAMPLES ** 1

7/27/12:00

OW 23 St. Louis Park, MN

Original Chain of Custody to Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST TO FILES Gridley Brooks

SAMPLES FOR: Brooks

SAMPLE LOCATION 1-2 FREEZER

REQUIRED ANALYSIS**

GC/MS - Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

☐ GAS CHROMATOGRAPHY ☐ NMR
☐ ULTRAVIOLET ☐ HPLC
☐ VISIBLE ☐ XRD
☐ INFRARED ☐ ICP
☐ EMISSION ☐ ATOMIC ABSORPTION
☐ EDAX XRF ☐ MASS SPEC
☐ MICROSCOPY ☐ GC/MS
☐ OTHER ______ ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME
B.M Hughes		

REQUIRED QA/QC

408327

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OTH

ANALYSIS REQUEST ORIGINATOR

SAMPLE TRANSMITTAL LETTER

Client MONSANTO (REILLY TAR) Project Title REILLY TAR (ST LOUIS PARK, MN)

Date Shipped 7-27-82. Shipped by ROSS Ohman. SOIL EXPLORATION CORP.

Shipped From Soil Exploration Company, 662 Cromwell Ave. ST PAUL MN 55114

Shipped To MONSANTO RESEARCH CORP. Attention of JOE BROOKS

Additional Shipping Information or Comments (H_2O ICE FREEZE)

Sample Description Code	COMMENTS:
7-27-12:00	GRAVISH - WATERY SOUPY LIQUID
OW23 ST LOUIS PARK MN	SOME TAR ODOR, SOME GAS FILM
DEPTH→850'	ON TOP, SOME SAND AND A PIECE
(BAILER SAMPLE)	OF SHALE.

Samples Received by Alan H Ford

Date Samples Received 7/28/82 seal intact.

Return Letter Received by Contract Laboratory ______ Date ______

MRC-QA #001T
061082lh

ANALYSIS REQUEST | DATE 7-30-82 | LOG NO. 1-82-07-30-01

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** Reilly Tar | CHARGE NO.** 215,45718

REPORT RESULTS TO*
FILES/KULIK
GRIDLEY
BROOKS

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 2 NUMBER OF SAMPLES ** 2

(1) 7/28/3:50Pm OW 23 St Louis Park, Mn
Bailer Sample Depth 861'

(2) 7/29/9:00 OW 23 St Louis Park, Mn
Bailer Sample Depth 861'B

Primarily Water Samples

Samples rec'd cool, not frozen, contain water.

ORIG. CHAIN OF CUSTODY LETTER TO GRIDLEY

RECORDED BY: RP

ANALYSIS REQUEST TO FILES
GRIDLEY
BROOKS

SAMPLES FOR:
BROOKS

SAMPLE LOCATION
1-21
R-8

REQUIRED ANALYSIS**

GC/MS – Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

Sa

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME
B.M. Hughes		

REQUIRED QA/QC

408119

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OTH

SAMPLE TRANSMITTAL LETTER

Client MONSANTO. REILLY TAR Project Title REILLY TAR OW#23. ST LOUIS PARK, MN

Date Shipped 7-29-82. Shipped by Ross Olman. S.E.C.

Shipped From SOIL EXPLORATION CO. 662 CROMWELL AVE ST PAUL 55114

Shipped To MONSANTO. ~~#~~ 1515 NICHOLAS RD. Attention of JOE BROOKS

Additional Shipping Information or Comments (H2O ICE FREEZE)

Sample Description Code	COMMENTS:
7/28/3:50 pm	
OW 23 ST LOUIS PARK, MN	WATERY – SOUPY, GRAY LIQUID
BAILER SAMPLE	SOME TAR FILM ON TOP.
DEPTH → 860'	
7/29/8:00	
OW 23 ST LOUIS PARK, MN	WATERY SOUPY GRAY LIQUID
BAILER SAMPLE.	SOME TAR FILM ON TOP
DEPTH – "861'B"	OF SAMPLE.
	Samples Rec'd Cool (not frozen).

Samples Received by [signature]

Date Samples Received 7-30-82 1:30 PM

Return Letter Received by Contract Laboratory ______ Date ______

MRC-QA #001T
061082lh

408020

ANALYSIS REQUEST | DATE 8/11/82 | LOG NO. 1-82-08-11-02

REPORT RESULTS TO** FILES/KULIK
Gridley

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** Reilly TAR / Gridley

CHARGE NO.** 215,45718

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 7 NUMBER OF SAMPLES ** 7

Primarily water Samples

08/05/09:25 - 100'
08/05/09:28 - 100'
08/05/14:30 - 468½'
08/06/08:23 - 752½'
08/06/18:00 } These two received broken - samples } 804½'
08/07/02:00 } apparently liquid which mixed with packing mat'l, wet ice etc. }
08/07/10:00 - 804½'

Original Chain of Custody to Gridley

RECORDED BY: a Ford

ANALYSIS REQUEST TO FILES
Brooks
Gridley
(SAMPLES)

SAMPLES FOR:
Brooks

SAMPLE LOCATION
1-2 F-G 8

REQUIRED ANALYSIS**

Hold GC/MS

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ____________

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ____ SEMIQUANT. ____ QUANT. ____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME
BMH		

REQUIRED QA/QC

408821

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OTH

SAMPLE TRANSMITTAL LETTER

Client REILLY TAR + CHEM Project Title REILLY TAR + CHEM ST LOUIS PARK, MN (CW #23)

Date Shipped 8/10/82 Shipped by ROSS OHMAN, SOIL EXP. CO.

Shipped From Soil Exploration company 662 cromwell Ave ST PAUL MN

Shipped To MONSANTO RESEARCH CORPORATION Attention of JOE BROOKS

Additional Shipping Information or Comments PACKED WITH H_2O ICE.

Sample Description Code	COMMENTS:
~~Comments~~	
08/05/09:25	Sample taken AT DISCHARGE BEFORE FILTER. (PUMP @ 100')
08/05/09:28	SAMPLE TAKEN AFTER DISCHARGE FILTER BEFORE ENTERING POND (PUMP @ 100')
08 05 14:30	SAMPLE TAKEN AT PUMP @ 668½'
08 06 08:23	SAMPLE TAKEN AT PUMP @ 752½' Δ4" @ 60.18' DM=7.36, 16 MIN SINCE PUMP REST
18/06/1800	SAMPLE TAKEN AT PUMP @ 804½'
0807 02:00	SAMPLE TAKEN AT PUMP @ 804½'
08 07 10:00	SAMPLE TAKEN AT PUMP @ 804½'

Samples Received by Alan H Ford (seal intact)

Date Samples Received 8/11/82 11:00

Return Letter Received by Contract Laboratory _____ Date _____

MRC-QA #001T
061082lh

4080222

8/12/82
N.

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS IN MUNICIPAL WATER WELLS FOR THE CITY OF ST. LOUIS PARK

Prepared by:

CAPSULE LABORATORIES
605 West County Rd E.
Shoreview, Minnesota 55112

Date Submitted:

August 12, 1982

May Sampling

TECHNICAL DATA

Report of Analyses to: City of St. Louis Park
Date Report Typed: August 12, 1982
Date Samples Submitted: June 4, 1982

PRIORITY POLLUTANT ANALYSIS (PNA's)[1]

Test	Well 7 Capsule # 13734.6	Well 11 Capsule # 13734.7	Well 12 Capsule # 13734.8	Well 3 Capsule # 13734.9	Well 4 Capsule # 13734.10
Acenaphthene	ND	ND	ND	ND	20
Acenaphthylene	ND	ND	ND	ND	ND
Anthracene	9.5	ND	11	ND	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
eno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND
thalene	ND	33	18	9.3	ND
Phenanthrene	ND	ND	ND	ND	68
Pyrene	ND	ND	ND	ND	ND

[1] Concentration expressed in parts-per-trillion (ng/l)

ND = Signal not observed or does not meet criteria for quantitation.

TECHNICAL DATA

Report of Analyses to: City of St. Louis Park
Date Report Typed: August 12, 1982
Date Samples Submitted: June 4, 1982

PRIORITY POLLUTANT ANALYSIS (PNA's)

Test	Well 6 Capsule # 13734-1	Well 8 Capsule # 13734-2	Well 13 Capsule # 13734.3	Well 14 Capsule # 13734.4	Well 16 Capsule # 13734.5
Acenaphthene	ND	ND	ND	ND	ND
Acenaphthylene	ND	ND	ND	ND	ND
Anthracene	ND	ND	80	54	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
`eno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND
,thalene	ND	ND	ND	ND	ND
Phenanthrene	ND	ND	ND	ND	ND
Pyrene	ND	ND	ND	ND	ND

[1] Concentration expressed in parts-per-trillion (ng/l)

ND = Signal not observed or does not meet criteria for quantitation.

TECHNICAL DATA

Report of Analyses to: City of St. Louis Park
Date Report Typed: August 12, 1982
Date Samples Submitted: June 4, 1982

PRIORITY POLLUTANT ANALYSIS (PNA's)

% Recoveries of Deuterated Spikes

Test	Well 7 Capsule # 13734.6	Well 11 Capsule # 13734.7	Well 12 Capsule # 13734.8	Well 3 Capsule # 13734.9	Well 4 Capsule # 13734.10
Acenaphthene					
Acenaphthylene					
Anthracene					
Benzo(a)anthracene					
Benzo(b)fluoranthene					
Benzo(k)fluoranthene					
Benzo(a)pyrene					
Benzo(g,h,i)perylene					
D_{12}Chrysene	200	18	16	35	30
Dibenzo(a,h)anthracene					
Fluoranthene					
Fluorene					
eno(1,2,3-cd)pyrene					
aphthalene	2.0	3.0	0.74	0.74	0.07
D_{10}Phenanthrene	6.2	53	42	47	50
D_{10}Pyrene	18	37	83	48	48
Spike Level	Medium	Low	Medium	Low	High

TECHNICAL DATA

Report of Analyses to: City of St. Louis Park
Date Report Typed: August 12, 1982
Date Samples Submitted: June 4, 1982

PRIORITY POLLUTANT ANALYSIS (PNA's)

% Recoveries of Deuterated Spikes

Test	Well 6 Capsule # 13734.1	Well 8 Capsule # 13734.2	Well 13 Capsule # 13734.3	Well 14 Capsule # 13734.4	Well 16 Capsule # 13734.5
Acenaphthene					
Acenaphthylene					
Anthracene					
Benzo(a)anthracene					
Benzo(b)fluoranthene					
Benzo(k)fluoranthene					
Benzo(a)pyrene					
Benzo(g,h,i)perylene					
D_{12}Chrysene	72	110	47	21	58
Dibenzo(a,h)anthracene					
Fluoranthene					
Fluorene					
deno(1,2,3-cd)pyrene					
D_8Naphthalene	0.07	0.33	2.6	0.74	3.0
D_{10}Phenanthrene	37	120	87	40	65
D_{10}Pyrene	5.9	52	52	42	55
Spike Level	High	High	Low	Medium	Low

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS

Sampling Equipment

Sampling resin beds used for organic enrichment are connected to a water source by an all-teflon manifold. The teflon manifold is designed to collect samples in duplicate by splitting sample flow with a tee to two resin beds. The inlet of the manifold is compatible with a 1/8" NPT female fitting on the water source. Two teflon needle valves (one on each side of the tee) are used to control water flow through the resin beds. A differential pressure of at least 20 psig is necessary for adequate flow control. When particulate levels are high, a teflon prefilter is placed upstream of the resin beds to remove particulates.

Sampling Procedure

Before sampling, all manifold parts are cleaned with HPLC-grade acetone and hexane. Preparation of the resin beds consists of flushing each with 4.0 ml HPLC-grade methanol, then 10.0 ml HPLC-grade water. One of the beds is spiked with isotope compounds in the laboratory. The spike level should be similar in concentration to the non-isotopic compounds being analyzed.

At the sampling site, the assembled teflon manifold and resin bed connections are leak-tested. The flow rate through each resin bed is adjusted using the flow valve and the sample flow volume maintained throughout sampling by periodic checks. The water after passing through each resin bed is collected in tared carboys. At the end of the sampling period, the water volume sampled is determined by weighing the carboy and water. At the completion of the sampling, the resin beds are wrapped in foil and kept refrigerated until analysis

Resin Bed Elution

Each resin bed used to collect and concentrate polynuclear aromatic compounds is eluted using acidified tetrahydrofuran (THF). The acidified THF is then passed through a micro-drying column to remove water. The dryed THF extract is collected in a 0.1 ml graduated vial. The micro-drying column is rinsed several times with acidified THF. The extract is then solvent exchanged and filtered. The volume of the extract is reduced under a gentle stream of nitrogen at room temperature. Finally, the concentrated extract is spiked with an isotope internal standard (D_{10}anthracene).

GC/MS Analysis

The extracts are stored in suitable vials until ready for analysis. A 1 μl aliquot is injected on the column in a splitless injection mode. Single ion monitoring data is continuously acquired and the data stored for later workup. Instrumental parameters are described in Table I.

Data Reduction - Quantitation

The single ion chromatograms are plotted for the characteristic ion of each polynuclear aromatic being analyzed. Areas are then obtained for any peak with a retention time falling within a one minute window relative to the

standard run. Confirmation of identity is based on presence of the EPA selected ions (see Table II) for the individual compound, and all ions must maximize within one scan of each other. Futhermore, the ions must meet spectral integrity criteria for relative ratios (±20%). The areas under each characteristic ion are used to determine the extract concentration. The areas are compared to the internal standard intensity based on the following formula.

$$\text{Concentration}_{\text{unk}} = \frac{(\text{Area}_{\text{unk}})\quad(\text{Conc}_{\text{IS}})}{(\text{Area}_{\text{IS}})\ (\text{R.F.}_{\text{unk}})\ (\text{Dilution})}$$

where: unk = priority pollutant being quantitated
IS = internal standard D_{10} anthracene
R.F.= response factor for the particular compound

Recovery Determinations

Each sample to be extracted is spiked with a surrogate standard (a deuterated analog). These materials are carried through the work-up procedure and quantitated along with the normal pollutants. The intensity of these spikes when compared to the area for D_{10} anthracene added to the final extract allows a percent recovery to be determined for each extraction.

$$\text{Percent Recovery} = \frac{\text{Concentration of Spike Observed}}{\text{Concentration of Spike Added to Sample}} \times 100$$

Matrix Spikes

In addition, a matrix spike is analyzed with each set of samples. The material being extracted is spiked with a mixture of polyaromatic hydrocarbons appropriate for the fractions being analyzed. The recoveries of compounds in the spiking mix will provide information about the matrix effect of the sample on the analytical methodology. Individual component recoveries of the matrix spike are calculated as follows:

$$\text{Percent Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where: SSR = Spike sample results (µg/g)
SR = Sample results (µg/g)
SA = Spike added (µg/g) from spiking mix

Duplicate Samples

Duplicate analyses are performed every 20 samples or one for each project, whichever is more frequent.

$$\text{Percent Difference} = \frac{D_1 - D_2}{(D_1 + D_2)} \times 100$$

Where: D_1 = First sample value
D_2 = Second sample value (duplicate)

Detection Limits[1]

The method detection limit is defined as the minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from replicate analysis of a sample of a given matrix containing analyte[2].

$$MDL = t\ (N-1,\ 1-\alpha = .99) \times Sc$$

Where: $t\ (N-1,\ 1-\alpha = .99)$ is students t value for one-tailed test at the 99% confidence level with N-1 degree of freedom.
Sc is the standard deviation of replicate analyses.

The method detection limit refers to samples processed through all steps comprising an established analytical procedure.

[1] Glaser, J.A., et al, "Trace Analyses for Wastewater," Environ. Sci. Tech., 15, 1426(1981).

[2] "Definition and Procedure for the Determination of the Method Detection Limit," Rev.1.12 45 EPA, Environmental Monitoring and Support Lab., Cincinnati, Jan. 1981.

The detection limit for each PNA is four parts-per-trillion in the well water.

TABLE I

INSTRUMENT PARAMETERS

Polynuclear Aromatics Analysis

Gas Chromatograph

Hewlett Packard 5840 with HP7671A Autosampler
Column 30m x 0.24mm DB-5 Fused Silicon Capillary (J & W)
Column directly coupled to MS

Injection

Mode: Splitless
Sweep Initiation @ 0.5 minutes
Sweep Flow: 40ml/min. Helium
Carrier Flow: 1cm/sec. linear velocity

Temperatures

Injector: 300°C
Temp. 1: 40°C for 3 minutes
Ramp: 10°C/minute
Temp. 2: 280°C for 20 minutes
Interface Temp: 300°C
Injection Volume: 2 µl

Mass Spectrometer

Hewlett Packard 5985B GCMS
Electron Impact Mode: 70eV
Delay: 11.5 minutes
SIM MODE
Dwell time: 100ms per ion
Multiplier Voltage: 2000V
Source Temp. 225°C

Computer

Hewlett Packard 21MX-E
Disk Drives: HP7906 (20M byte) HP7920 (50M byte)
Tape Drive: Kennedy 9300 9-track dual density

TABLE II

Ion (abundances)

Compound	Primary	Confirming		R.T.
Naphthalene	128(100)	127(12)	129(10)	12.8
Acenaphthylene	152(100)	151(21)	153(13)	16.7
Acenaphthene	154(100)	153(118)	152(59)	17.2
Fluorene	166(100)	165(98)	167(14)	18.5
Phenanthrene	178(100)	176(20)	179(16)	20.8
Anthracene	178(100)	176(22)	179(19)	21.0
Fluoranthene	202(100)	101(19)	100(14)	23.8
Pyrene	202(100)	101(21)	100(18)	24.3
Benzo(a)anthracene	228(100)	226(25)	229(20)	27.3
Chrysene	228(100)	229(19)	226(28)	27.5
Benzo(b)fluoranthene	252(100)	253(23)	125(15)	30.6
Benzo(k)fluoranthene	252(100)	253(22)	125(16)	30.9
Benzo(a)pyrene	252(100)	253(24)	125(16)	32.0
Indeno(1,2,3-c,d)pyrene	276(100)	138(31)	277(24)	37.8
Dibenzo(a,h)anthracene	278(100)	139(25)	279(24)	38.2
Benzo(g,h,i)perylene	276(100)	138(34)	277(22)	39.7

8/6/82
N.

GCA

GCA CORPORATION
Technology Division

213 Burlington Road
Bedford, Massachusetts 01730
Telephone 617-275-5444
Telex 92-3339

6 August 1982

Environmental Protection Agency
401 M Street, S.W.
Washington, DC 20460

Attention: Julie Klaas

Subject: Contract No. 68-01-6316, Technical Service Area 1, Assignment 24, Task A - E, (GCA 1-452-124)

Gentlemen:

In accordance with Paragraph VI, Reporting Requirements of the subject Assignment, enclosed herewith is one (1) copy of Monthly Progress Report Nos. 7,8,9,10,11 and 12 covering the period 1 February through 31 July 1982.

Very truly yours,

Arthur Engelman
ea

Arthur Engelman
Manager, Contract Administration

AE:eia

Enclosure (1)

cc: Mr. John R. Busik
(w/1 copy)

✓Mr. Mike Kosakowski
(w/1 copy)

ANALYSIS OF ENVIRONMENTAL SAMPLES FOR REGION V

Monthly Progress Report Nos. 7,8,9,10,11,12, for the Period

1 February through 31 July 1982

Prepared for

U.S. ENVIRONMENTAL PROTECTION AGENCY
DIVISION OF STATIONARY SOURCE ENFORCEMENT
Washington, D.C. 20460

Contract No. 68-01-6316
Technical Service Area 1
Assignment No. 24

August 1982

Kenneth T. McGregor

GCA CORPORATION
GCA/TECHNOLOGY DIVISION
Bedford, Massachusetts

SECTION 1

PURPOSE OF TASK

The purpose of this work assignment is to provide support services to EPA Region V for the analysis of environmental samples. These services will consist of analyses of water, soil, sludge, and oil-phase water samples for several organic and inorganic components. Specifically, the samples will be analyzed for some or all of the following parameters:

- Priority pollutants
  - Volatile organics
  - Extractable organics
  - Pesticides/PCBs
  - Trace metals
  - Cyanide and phenols
- Nonpriority pollutants
  - PAH compounds
  - Methyl ethyl ketone
  - Hexavalent chromium
  - Nonfilterable residue
  - Total organic carbon
  - Cation exchange capacity
  - Conventional pollutants

The five tasks included in this work assignment will be conducted in accordance with the analytical procedures and quality assurance/quality control protocols outlined in the Work Plans submitted for these tasks.

SECTION 2

PROGRESS DURING REPORTING PERIOD

TASK A

Photographs were taken of five samples from the Fisher-Calo program.

TASK B

Analysis has been completed and data transmitted on four municipal well water samples.

TASK C

The following sample preparation, analysis, and transmittal procedures were initiated and/or completed during this reporting period.

- PAH analysis by HPLC-fluorescence of eleven water samples from the Mississippi River.
- PAH analysis by HPLC-fluorescence of fifteen water samples from the MWCC.
- PAH analysis by HPLC-fluorescence of four empty sample containers (field blanks).
- Sample preparation was carried out on four sludge samples from MWCC for PAH analysis by GC/MS.

Preliminary data are available, and included with this report, for nonfilterable residue from eleven water samples from the Mississippi River.

TASKS D AND E

To date, no work has been performed under these tasks.

SECTION 3

CURRENT PROBLEMS

TASK C

A delay occurred during the analysis of the water samples from the Mississippi River and MWCC. The delay was due to a malfunctioning integrator on the HPLC-fluorescence system.

SECTION 4

WORK TO BE PERFORMED DURING NEXT REPORTING PERIOD

TASK C

Results of analysis for PAHs on the four sludge samples from the MWCC will be submitted.

TASKS D AND E

No activity is planned during August.

/

NONFILTERABLE RESIDUE

Project: 1-452-124C

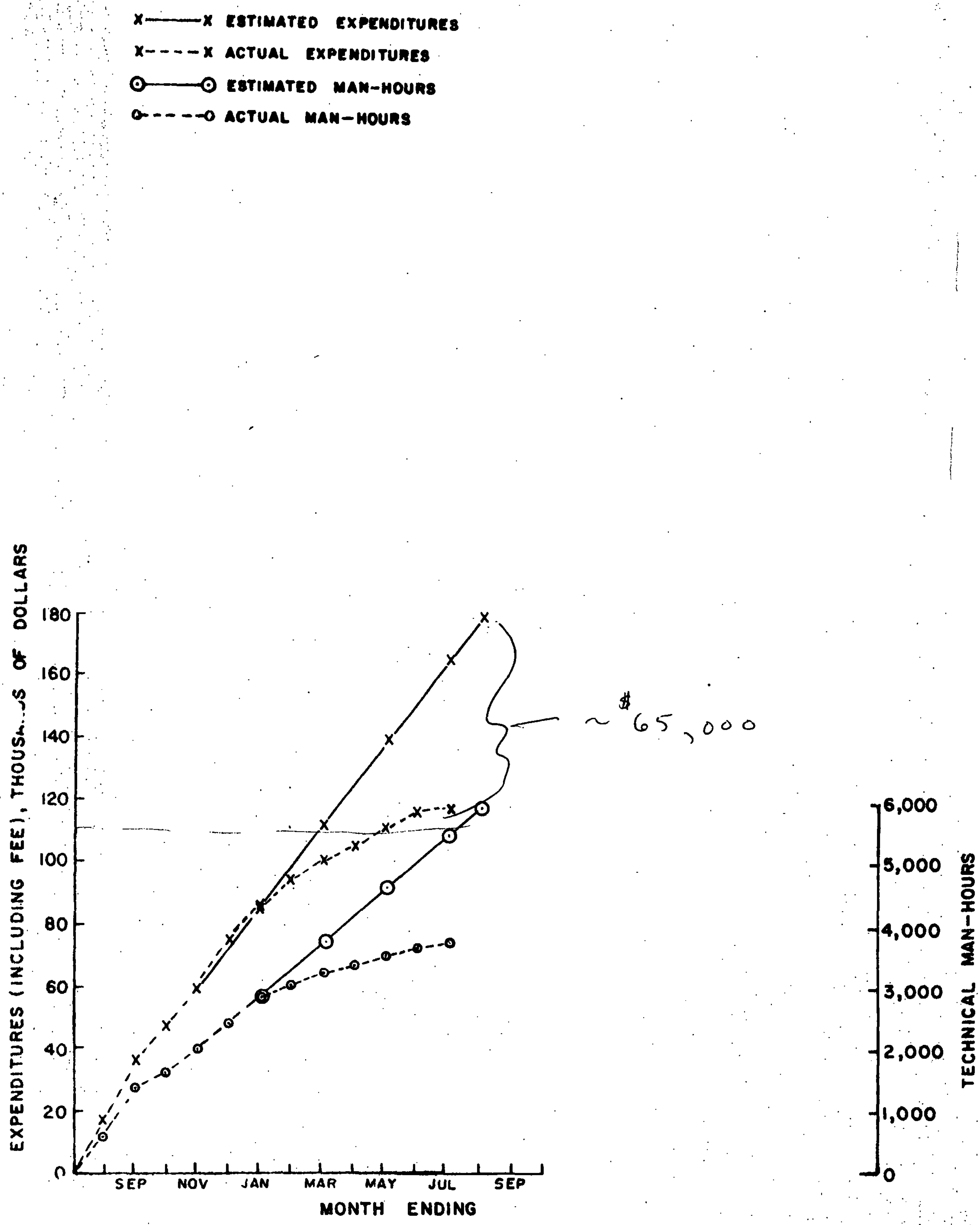
Sample Matrix: Water

Analytical Method: Methods for Chemical Analysis of Water and Wastes EPA-600/4-79-020

Sample I.D.	GCA Control No.	Residue (mg/l)
UM-827	18830	< 10
UM-840	18831	< 10
UM-847	18832	< 10
UM-859	18833	< 10
FORD DAM	18834	< 10
FORD DAM	18942	< 10
GRAY CLOUD	18943	< 10
UM-827	18944	< 10
UM-840	18945	< 10
UM-847	18946	< 10
UM-859	18947	< 10

An aliquot of EPA WP/080, concentrate 1, gave a recovery of 87 percent.

CONTRACT NO. 68-01-6316
TSA 1, TASK 24
(GCA 1-452-124) REVISED 12/16/81



8/2/82
N.

CAPSULE
LABORATORIES

ADVANCED TECHNOLOGY DIVISION
A Division of Economics Laboratory, Inc.
605 West County Road E, St. Paul, MN 55112, (612) 482-8855

August 2, 1982

Mr. Vern Tollefsrud
City of St. Louis Park
5005 Minnetonka Blvd.
St. Louis Park, MN 55416

Dear Mr. Tollefsrud:

Enclosed are the results of the analysis for polynuclear aromatic hydrocarbons in St. Louis Park Well #5 well water. Two separate 8 liter samples of well water collected July 13, 1982, and July 14, 1982, were analyzed. The analyses were conducted by single ion monitoring (SIM) GC/MS on extracts of the samples prepared using the EPA Method #610 liquid-liquid technique. The samples were spiked with deuterated analogs for percent recovery determinations.

If you have any questions regarding these results, please feel free to contact us.

Sincerely,

CAPSULE LABORATORIES

Wayne A. Olson

Wayne A. Olson
Principal Chemist PaL

WAO:jjd

TECHNICAL DATA

Report of Analyses to: City of Saint Louis Park

PRIORITY POLLUTANT ANALYSIS (PNA'S)[1]

	Sampled 7/13/82 Capsule # 13931.01 Well # 5	Sampled 7/14/82 Capsule # 13931.02 Well # 5
Acenaphthene	12	42
Acenaphthylene	ND	19
Anthracene	ND	ND
Benzo(a)anthracene	ND	ND
Benzo(b)fluoranthene	ND	ND
Benzo(k)fluoranthene	ND	ND
Benzo(a)pyrene	ND	ND
Benzo(g,h,i)perylene	ND	ND
Chrysene	ND	ND
Dibenzo(a,h)anthracene	ND	ND
Fluoranthene	ND	ND
Fluorene	20	46
Indeno(1,2,3-c,d)pyrene	ND	ND
Naphthalene	ND	ND
Phenanthrene	ND	ND
Pyrene	ND	ND

(1) Concentration expressed as parts-per-trillion(ng/l)

N.D. = Signal not observed or does not meet criteria for quantitation

TECHNICAL DATA

Report of Analyses to: City of Saint Louis Park

PRIORITY POLLUTANT ANALYSIS (PNA'S)

	μg Spiked	Deuterated Spike % Recovery 13931.01 Well # 5	Deuterated Spike % Recovery 13931.02 Well # 5
D_{12}Benzo(a)pyrene	24	130%	63%
D_{12}Chrysene	22	43%	34%
D_8Naphthalene	22	29%	17%
D_{10}Phenanthrene	26	46%	34%
D_{10}Pyrene	22	45%	34%

TABLE II

Ion (abundances)

Compound	Primary	Confirming		R.T.
Naphthalene	128(100)	127(13)	129(11)	12.8
Acenaphthylene	152(100)	151(21)	153(13)	16.7
Acenaphthene	154(100)	153(110)	152(54)	17.2
Fluorene	166(100)	165(96)	167(13)	18.5
Phenanthrene	178(100)	176(20)	179(16)	20.8
Anthracene	178(100)	176(21)	179(18)	21.0
Fluoranthene	202(100)	101(20)	100(14)	23.8
Pyrene	202(100)	101(23)	100(18)	24.3
Benzo(a)anthracene	228(100)	226(24)	229(19)	27.3
Chrysene	228(100)	229(19)	226(27)	27.5
Benzo(b)fluoranthene	252(100)	253(23)	125(15)	30.6
Benzo(k)fluoranthene	252(100)	253(22)	125(16)	30.9
Benzo(a)pyrene	252(100)	253(24)	125(16)	32.0
Indeno(1,2,3-c,d)pyrene	276(100)	138(31)	277(24)	37.8
Dibenzo(a,h)anthracene	278(100)	139(25)	279(24)	38.2
Benzo(g,h,i)perylene	276(100)	138(34)	277(22)	39.7

$$\text{Percent Difference} = \frac{D_1 - D_2}{(D_1 + D_2)} \times 100$$

Where: D_1 = First sample value
D_2 = Second sample value (duplicate)

Detection Limits[1]

The method detection limit is defined as the minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from replicate analysis of a sample of a given matrix containing analyte[2].

$$MDL = t\ (N-1,\ 1-\alpha = .99) \times Sc$$

Where: $t\ (N-1,\ 1-\alpha = .99)$ is students t value for one-tailed test at the 99% confidence level with N-1 degree of freedom.
Sc is the standard deviation of replicate analyses.

The method detection limit refers to samples processed through all steps comprising an established analytical procedure.

[1] Glaser, J.A., et al, "Trace Analyses for Wastewater," Environ. Sci. Tech., 15, 1426(1981).

[2] "Definition and Procedure for the Determination of the Method Detection Limit," Rev.1.12 45 EPA, Environmental Monitoring and Support Lab., Cincinnati, Jan. 1981.

The detection limit for each PNA is four parts-per-trillion in the well water.

TABLE I

INSTRUMENT PARAMETERS

Polynuclear Aromatics Analysis

Gas Chromatograph

Hewlett Packard 5840 with HP7671A Autosampler
Column 30m x 0.24mm DB-5 Fused Silicon Capillary (J & W)
Column directly coupled to MS

Injection

Mode: Splitless
Sweep Initiation @ 0.5 minutes
Sweep Flow: 40ml/min. Helium
Carrier Flow: 1cm/sec. linear velocity

Temperatures

Injector: 300°C
Temp. 1: 40°C for 3 minutes
Ramp: 10°C/minute
Temp. 2: 280°C for 20 minutes
Interface Temp: 300°C
Injection Volume: 2 µl

Mass Spectrometer

Hewlett Packard 5985B GCMS
Electron Impact Mode: 70eV
Delay: 11.5 minutes
SIM MODE
Dwell time: 100ms per ion
Multiplier Voltage: 2000V
Source Temp. 225°C

Computer

Hewlett Packard 21MX-E
Disk Drives: HP7906 (20M byte) HP7920 (50M byte)
Tape Drive: Kennedy 9300 9-track dual density

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS IN MUNICIPAL WATER WELLS FOR THE CITY OF ST. LOUIS PARK

Prepared by:

CAPSULE LABORATORIES
605 West County Rd E.
Shoreview, Minnesota 55112

Date Submitted:

August 6, 1982

TECHNICAL DATA

Report of Analyses to: City of St. Louis Park
Date Samples Submitted: June 4, 1982

PRIORITY POLLUTANT ANALYSIS (PNA's)[1]

Test	Well 3 Capsule # 13889.01	Well 6 Capsule # 13889.02	Well 8 Capsule # 13889.03	Well 14 Capsule # 13889.04	Well 16 Capsule # 13889.05
naphthene	ND	ND	ND	ND	ND
naphthylene	ND	ND	ND	ND	ND
Anthracene	ND	ND	ND	60	ND
Benzo(a)anthracene	ND	ND	ND	ND	ND
Benzo(b)fluoranthene	ND	ND	ND	ND	ND
Benzo(k)fluoranthene	ND	ND	ND	ND	ND
Benzo(a)pyrene	ND	ND	ND	ND	ND
Benzo(g,h,i)perylene	ND	ND	ND	ND	ND
Chrysene	ND	ND	ND	ND	ND
Dibenzo(a,h)anthracene	ND	ND	ND	ND	ND
Fluoranthene	ND	ND	ND	ND	ND
Fluorene	ND	ND	ND	ND	ND
Indeno(1,2,3-cd)pyrene	ND	ND	ND	ND	ND
Naphthalene	ND	5.3	ND	ND	4.8
Phenanthrene	ND	ND	ND	5.2	ND
Pyrene	ND	ND	ND	4.0	ND

Concentration expressed in parts-per-trillion (ng/l).

N.D. = Signal not observed or does not meet criteria for quantitation.

TECHNICAL DATA

Report of Analyses to: City of St. Louis Park
Date Samples Submitted: June 4, 1982

PRIORITY POLLUTANT ANALYSIS (PNA's)

% Recoveries of Deuterated Spikes

Test	Well 3 Capsule # 13889.01	Well 6 Capsule # 13889.02	Well 8 Capsule # 13889.03	Well 14 Capsule # 13889.04	Well 16 Capsule # 13889.05
Acenaphthene					
Acenaphthylene					
Anthracene					
Benzo(a)anthracene					
Benzo(b)fluoranthene					
Benzo(k)fluoranthene					
Benzo(a)pyrene					
Benzo(g,h,i)perylene					
D_{12}Chrysene	85	77	68	68	47
Dibenzo(a,h)anthracene					
Fluoranthene					
Fluorene					
Indeno(1,2,3-cd)pyrene					
D_8Naphthalene	0.6	0.3	0.2	0.1	0.8
D_{10}Phenanthrene	110	50	50	71	68
D_{10}Pyrene	63	81	48	76	57
Spike Level	Low	High	High	Medium	Low

TECHNICAL DATA

Report of Analyses to: City of St. Louis Park
Date Samples Submitted: June 4, 1982

PRIORITY POLLUTANT ANALYSIS (PNA'S)

Level of Deuterated Spikes

Test	Low Spike (ng)	Medium Spike (ng)	High Spike (ng)
-enaphthene			
Acenaphthylene			
Anthracene			
Benzo(a)anthracene			
Benzo(b)fluoranthene			
Benzo(k)fluoranthene			
Benzo(a)pyrene			
Benzo(g,h,i)perylene			
D_{12}- Chrysene	555	1110	5550
Dibenzo(a,h)anthracene			
Fluoranthene			
Fluorene			
Indeno(1,2,3-cd)pyrene			
D_8-Naphthalene	538	1077	5385
D_{10}-Phenathrene	643	1286	6430
D_{10}-Pyrene	542	1085	5425

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS

Sampling Equipment

Sampling resin beds used for organic enrichment are connected to a water source by an all-teflon manifold. The teflon manifold is designed to collect samples in duplicate by splitting sample flow with a tee to two resin beds. The inlet of the manifold is compatible with a 1/8" NPT female fitting on the water source. Two teflon needle valves (one on each side of the tee) are used to control water flow through the resin beds. A differential pressure of at least 20 psig is necessary for adequate flow control. When particulate levels are high, a teflon prefilter is placed upstream of the resin beds to remove particulates.

Sampling Procedure

Before sampling, all manifold parts are cleaned with HPLC-grade acetone and hexane. Preparation of the resin beds consists of flushing each with 4.0 ml HPLC-grade methanol, then 10.0 ml HPLC-grade water. One of the beds is spiked with isotope compounds in the laboratory. The spike level should be similar in concentration to the non-isotopic compounds being analyzed.

At the sampling site, the assembled teflon manifold and resin bed connections are leak-tested. The flow rate through each resin bed is adjusted using the flow valve and the sample flow volume maintained throughout sampling by periodic checks. The water after passing through each resin bed is collected in tared carboys. At the end of the sampling period, the water volume sampled is determined by weighing the carboy and water. At the completion of the sampling, the resin beds are wrapped in foil and kept refrigerated until analysis

Resin Bed Elution

Each resin bed used to collect and concentrate polynuclear aromatic compounds is eluted using acidified tetrahydrofuran (THF). The acidified THF is then passed through a micro-drying column to remove water. The dryed THF extract is collected in a 0.1 ml graduated vial. The micro-drying column is rinsed several times with acidified THF. The extract is then solvent exchanged and filtered. The volume of the extract is reduced under a gentle stream of nitrogen at room temperature. Finally, the concentrated extract is spiked with an isotope internal standard (D_{10}anthracene).

GC/MS Analysis

The extracts are stored in suitable vials until ready for analysis. A 1 µl aliquot is injected on the column in a splitless injection mode. Single ion monitoring data is continuously acquired and the data stored for later workup. Instrumental parameters are described in Table I.

Data Reduction - Quantitation

The single ion chromatograms are plotted for the characteristic ion of each polynuclear aromatic being analyzed. Areas are then obtained for any peak with a retention time falling within a one minute window relative to the

standard run. Confirmation of identity is based on presence of the EPA selected ions (see Table II) for the individual compound, and all ions must maximize within one scan of each other. Futhermore, the ions must meet spectral integrity criteria for relative ratios (±20%). The areas under each characteristic ion are used to determine the extract concentration. The areas are compared to the internal standard intensity based on the following formula.

$$\text{Concentration}_{\text{unk}} = \frac{(\text{Area}_{\text{unk}})\quad(\text{Conc}_{\text{IS}})}{(\text{Area}_{\text{IS}})\ (\text{R.F.}_{\text{unk}})\ (\text{Dilution})}$$

where: unk = priority pollutant being quantitated
IS = internal standard D_{10} anthracene
R.F.= response factor for the particular compound

Recovery Determinations

Each sample to be extracted is spiked with a surrogate standard (a deuterated analog). These materials are carried through the work-up procedure and quantitated along with the normal pollutants. The intensity of these spikes when compared to the area for D_{10} anthracene added to the final extract allows a percent recovery to be determined for each extraction.

$$\text{Percent Recovery} = \frac{\text{Concentration of Spike Observed}}{\text{Concentration of Spike Added to Sample}} \times 100$$

Matrix Spikes

In addition, a matrix spike is analyzed with each set of samples. The material being extracted is spiked with a mixture of polyaromatic hydrocarbons appropriate for the fractions being analyzed. The recoveries of compounds in the spiking mix will provide information about the matrix effect of the sample on the analytical methodology. Individual component recoveries of the matrix spike are calculated as follows:

$$\text{Percent Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where: SSR = Spike sample results (μg/g)
SR = Sample results (μg/g)
SA = Spike added (μg/g) from spiking mix

Duplicate Samples

Duplicate analyses are performed every 20 samples or one for each project, whichever is more frequent.

7/26/82
N.

RECEIVED

JUL 2 ...

MINN. POLLUTION
CONTROL AGENCY

545 Indian Mound
Wayzata, Minnesota 55391
(612) 473-4224

July 26, 1982

Mr. Mike Hansel
Regulatory Compliance Section
Solid and Hazardous Waste Division
Minnesota Pollution Control Agency
1935 West County Road B-2
Roseville, Minnesota 55113

Re: St. Louis Park Well Abandonment Program

Dear Mr. Hansel:

Attached are the results of the soil sample submitted to the Iowa Hygienic Laboratory. This sample was taken from a depth of 690 feet on July 6, 1982.

The sample was split into three fractions by dissolving the sample in dichloromethane (85% soluble) and extracting with acid (1% soluble) and then base (1% soluble). All compounds identified are at concentrations greater than 10 mg/l.

Sincerely,

EUGENE A. HICKOK AND ASSOCIATES

George W. Boyer, P.E.
Vice President

bt

Enclosure

9626741

The University of Iowa

Iowa City, Iowa 52242

University Hygienic Laboratory

(319) 353-5990

RECEIVED JUL 23 1982

20 July 1982

E.A. Hickok and Associates
545 Indian Mound
Wayzata, MN 55391

Attn: Mr. George Boyer

RE: UHL #2-2346

Dear George:

Attached are the results of the "soil" analysis from St. Louis Park. As discussed with Ms. Patt Cain the sample was split into three fractions by dissolving the sample in dichloromethane (85% soluble) and extracting with acid (1% soluble) and then base (1% soluble). All compounds identified are at concentrations greater than 10 ppm.

Sincerely,

[signature] Ph.D.

Armand F. Lange, Ph.D.
Chief, Organic Analytical Division

lm

enclosure

cc: Dr. Splinter
Dr. Hahne
Ms. Cain
Mr. Brewer
File

Analysis of [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] [illegible] Attached [illegible] [illegible] [illegible] M. [illegible] 4/87

9626742

Qualitative Analysis

Sample 2-2346

Acid Extract

Scan #	Compound
826	Naphthalene
962	2-Methyl naphthalene
982	1-Methyl naphthalene
979	2-Methyl quinoline
1055	
1103	Dimethyl quinoline (3 isomers)
1126	
1169	
1192	
1195	C_3 Quinoline* (6 isomers)
1198	
1204	
1239	
1264	C_4 Quinoline*
1314	9H-Carbazole
1329	2-Methyl naphthylisocyanide
1380	9-Methyl-9H-carbazole
1399	N-(phenylmethyl)-benzenemethanamine
1439	[1,1'-Biphenyl]-2-carboxamide
1457	Anthracene/phenanthrene
1466	Acridine
1476	Benzo[h]quinoline
1497	9H-Fluoren-9-imine
1519	Methyl acridine

Qualitative Analysis
Sample 2-2346
Acid Extract

Scan #	Compound	
1555 1565 1578 1595	Methyl benzo[f]quinoline	(4 isomers)
1617 1626	Phenylindole	(2 isomers)
1610 1618 1625 1631 1639 1652 1658 1661 1669 1675 1688 1692	Methyl-phenyl-1H-indole	(12 isomers)
1703 1719 1765 1788	Anthracenecarbonitrile	(4 isomers)
1809 1821 1856 1881	Methyl anthracenecarbonitrile	(4 isomers)

Qualitative Analysis
Sample 2-2346
Acid Extract

Scan #	Compound	
1853		
1895	Diphenylpyridene	(3 isomers)
1907		
2040	Methyl benz[c]acridene	(2 isomers)
2047		
2451	Dibenz[a,j]acridene	

*C_3, C_4 etc - the compound has additional Methyl (CH_3), Ethyl (CH_3, CH_2) etc. Groups attached to total the subscripted number of additional carbon atoms.

Qualitative Analysis

Sample 2-2346

Base Extract

Scan #	Compound	
850	Naphthalene	
992	2-Methyl naphthalene	
1012	1-Methyl naphthalene	
1121		
1137		
1141	C_2 Naphthalene *	(4 isomers)
1159		
1172	Acenaphthylene	
1209	1,2-Dihydroacenaphthylene	
1244	Dibenzofuran	
1244	Naphthalenol	
1311	9H-Fluorene	
1341	Methyl naphthalenol	
1442	Dimethyl-1-naphthol	
1489	Dibenzodioxin	(2 isomers)
1556		
1502	Anthracene/Phenanthrene	
1528	3-Methoxy-1,1'-biphenyl	
1569		
1586	Methyl dibenzothiophene	(4 isomers)
1662		
1674		
1639	Methyl 9H-Pyrido[3,4-b]indol-7-ol	(2 isomers)
1650		

9626746

Qualitative Analysis
Sample 2-2346
Base Extract

Scan #	Compound	
1608	Methyl dibenzofuran	(2 isomers)
1628		
1742	Fluoranthene	
1785	Pyrene	
1794	4-Methyl benzo[c]cinnoline	
1804	1-Phenanthrenol	

* C_3,C_4 etc The compound has additional Methyl(CH_3), Ethyl(CH_3CH_2) etc. Groups attached to total the subscripted number of additional carbon atoms.

Qualitative Analysis

Sample 2-2346

Neutral Extract

Scan #	Compound	
362	Ethylbenzene	
374	Xylene	(3 isomers)
411		
524		
533		
573	C_3 Benzene *	(4 isomers)
618		
638	1-Propenyl benzene	
652	1H-Indene	
672		
703		
712	C_4 Benzene *	(5 isomers)
756		
762		
714	1-Ethenyl-3-ethylbenzene	
728	1-Ethenyl-3,5-dimethylbenzene	
741	Methyl benzofuran	
769	1-Methyl-2-(2-propenyl)benzene	
789	2,3-Dihydro-4-methyl-1H-indene	
804		
812	Methyl-1H-indene	(3 isomers)
824		
856	Naphthalene	
863	Benzo[b]thiophene	
866	Methyl decane	

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound	
930	1,2-Dihydro-2-methyl naphthalene	
935	2,3-Dihydro-4,7-dimethyl-1H-indene	
942	1,2-Dihydro-3-methyl naphthalene	
945	1,1-Dimethyl-1H-indene	
956	1,2-Dihydro-6-methyl naphthalene	
997	2-Methyl naphthalene	
1005	6-Methyl benzo[b]thiophene	
1017	1-Methyl naphthalene	
1093	1,1'-Biphenyl	
1110		
1123		
1140	C_2 Naphthalene*	(6 isomers)
1144		
1162		
1179		
1131	Dihydroacenaphthylene	(2 isomers)
1150		
1175	Acenaphthylene	
1208		
1218		
1270	Methyl-1,1'-biphenyl	(5 isomers)
1283		
1259		
1213	Acenaphthene	

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound	
1229	2-(1-Methylethyl)-naphthalene	
1246	Dibenzofuran	
1252		
1258		
1275	C_3 Naphthalene *	(5 isomers)
1278		
1292		
1295	1H-Phenalene	
1316	9H-Fluorene	
1340	1-(2-Propenyl)-naphthalene	
1351		
1364	Methyl dibenzofuran	(3 isomers)
1376		
1386	Dimethyl Biphenyl	
1397	1-Methyl-7-(1-methylethyl)-naphthalene	
1406	9,10-Dihydrophenanthrene	
1427		
1434	Methyl-9H-fluorene	(3 isomers)
1444		
1459	2-Methoxy-9H-fluorene	
1480	Dibenzothiophene	
1510	Anthracene/Phenanthrene	
1545	Dimethyl-9H-fluorene	
1555	9H-Carbazole	

Qualitative Analysis

Sample 2-2346

Neutral Extract

Scan #	Compound	
1571	1-Phenyl naphthalene	
1605		
1611		
1619	Methyl phenanthrene	(5 isomers)
1628		
1632		
1697		
1704	C_2 Phenanthrene *	(3 isomers)
1720		
1747	Fluoranthene	
1790	Pyrene	
1839	Methyl pyrene	(2 isomers)
1860		
1873	11H-Benzo[a]fluorene	
1893	11H-Benzo[b]fluorene	
1947	1,1':2',1"-Terphenyl	
1983	Benzo[b]naphtho[1,2-d]thiophene	
1990	Benzo[c]phenanthrene	
2031	Chrysene	
2039	Benz[a]anthracene	
2054	triphenylene	
2106		
2114	Methyl [chrysene / benz[a]anthracene / triphenylene]	(4 isomers)
2121		
2131		

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound
2239	Benzo[k]fluoranthene
2256	Benzo[j]fluoranthene
2289	Benzo[e]pyrene
2300	Benzo[a]pyrene
2317	Perylene
2577	Indeno[1,2,3,-cd]pyrene
2585	Dibenzanthracene
2651	Benzo(ghi)perylene
3088	Dibenzpyrene

* C_3,C_4 etc The compound has additional Methyl(CH_3), Ethyl(CH_3CH_2) etc. Groups attached to total the subscripted number of additional carbon atoms.

7/20/82
N. RECD JUL 26 1982
7-20-82

MONSANTO RESEARCH CORPORATION

Inter-Office Correspondence

From LOCATION : B. M. Hughes, Analytical Technology, Dayton

DATE : 20 July 1982

SUBJECT : 215.45718

REFERENCE : U.S.A. v. Reilly Tar and Chemical Corporation

cc : William Gregg/ERT
Jerry R. Rick/SEC
J. J. Brooks/MRC
P. M. Rivers/RTC

TO : Edward J. Schwartzbauer
Dorsey, Windhorst, Hannaford, Whitney, & Halladay
2200 First Bank Place East
Minneapolis, Minnesota 55402

In order to properly plan an analytical program which may best fit the needs of Reilly Tar and Chemical Corp., a study was conducted in which an aliquot of the tar from Well 23 (log no. 1-82-06-14-06, sample no. 6-11-1021) was analyzed for the major chromatographable species which were present. Figure 1 shows the total ion chromatogram from the capillary GC/MS analysis of a methylene chloride solution containing 0.00571 g/ml of the Well 23 tar. Table 1 shows the results of a detailed analysis of this mass spectral data and compares the present results with those from Midwest Research Institute (MRI) [authored by E. E. Conrad, et al] and entitled "Results of Analysis of Water Samples, Sludge Sample and Soil Samples for Polycyclic Aromatic Compounds (Hydrocarbons, Azaarenes, Phenols)". As can be seen, generally good agreement is seen between the two sets of data. The present results shown in Table 1 do not use specific PNA analytical standards for each PNA detected. Therefore, these data are estimates with accuracies on the order of a factor of two or three.

Several important conclusions can be drawn from the data shown in Table 1. The following paragraphs outline important features of these data, and suggest experimental approaches which may be of interest to Reilly Tar and Chemical Corp.

(1) The present data agree very well with that reported by MRI. However, it is significant that a number of important methyl-PNAs, dihydroacenaphthene and dibenzofuran, were not measured in the MRI study. The presence or absence of these compounds may be highly significant in differentiating Well 23 from other possible PNA sources, especially if the methyl-PNAs, dihydroacenaphthene and dibenzofuran can be shown to be absent in St. Louis Park (SLP) well samples.

(2) Although the compounds identified in Table 1 are not by far a complete list of compounds in the tar from Well 23, the compounds that we detected would be the basis of any detailed analytical studies which we would conduct in an effort to clarify the source of SLP water contamination. One disturbing feature of the water and tar analysis data reported by MRI and referenced above is the difference in the PNA distribution of the Well 23 and NAT LEAD water samples and the PNA distribution in the tar sample from Well 23 (shown in Table 1 of this report). We feel it is important at this time to conduct laboratory experiments to determine what PNA distribution would result from prolonged exposure of the tar sample from Well 23 to a sample of organic-free water. This study could be completed by the middle of August and may demonstrate what concentrations and PNA distributions could be expected from prolonged exposure of the tar to water. If the naphthalene concentration in the exposed water sample is ten times higher than phenanthrene, fluoranthene

and pyrene, as is the case for the water samples from Well 23 and NAT LEAD reported by MRI, then the source of these PNAs can be assumed to be due to the tar injected into Well 23. On the other hand, if the distribution is very different from that reported by the MRI study, then there is a good probability that the PNAs in the water sample of Well 23 and NAT LEAD are due to alternate sources. This same tar/water exposure study can be used to investigate the concentrations of the methyl-PNAs, dihydroacenaphthene and dibenzofuran which were unreported in the MRI study. This single investigation could be important in developing the strategy of a pattern comparison study of water samples from SLP and tar from Well 23 or other PNA sources, if this approach is chosen by Reilly Tar and Chemical Corporation.

If you feel we should pursue the above experiemental approach in determining the distribution of PNAs, methyl-PNAs, dihydroacenaphthene and dibenzofuran from the exposure of Well 23 tar to organic-free water, contact me or Joe Brooks immediately so that we may begin these studies as soon as possible.

B. Mason Hughes

B. Mason Hughes

BMH/cvd

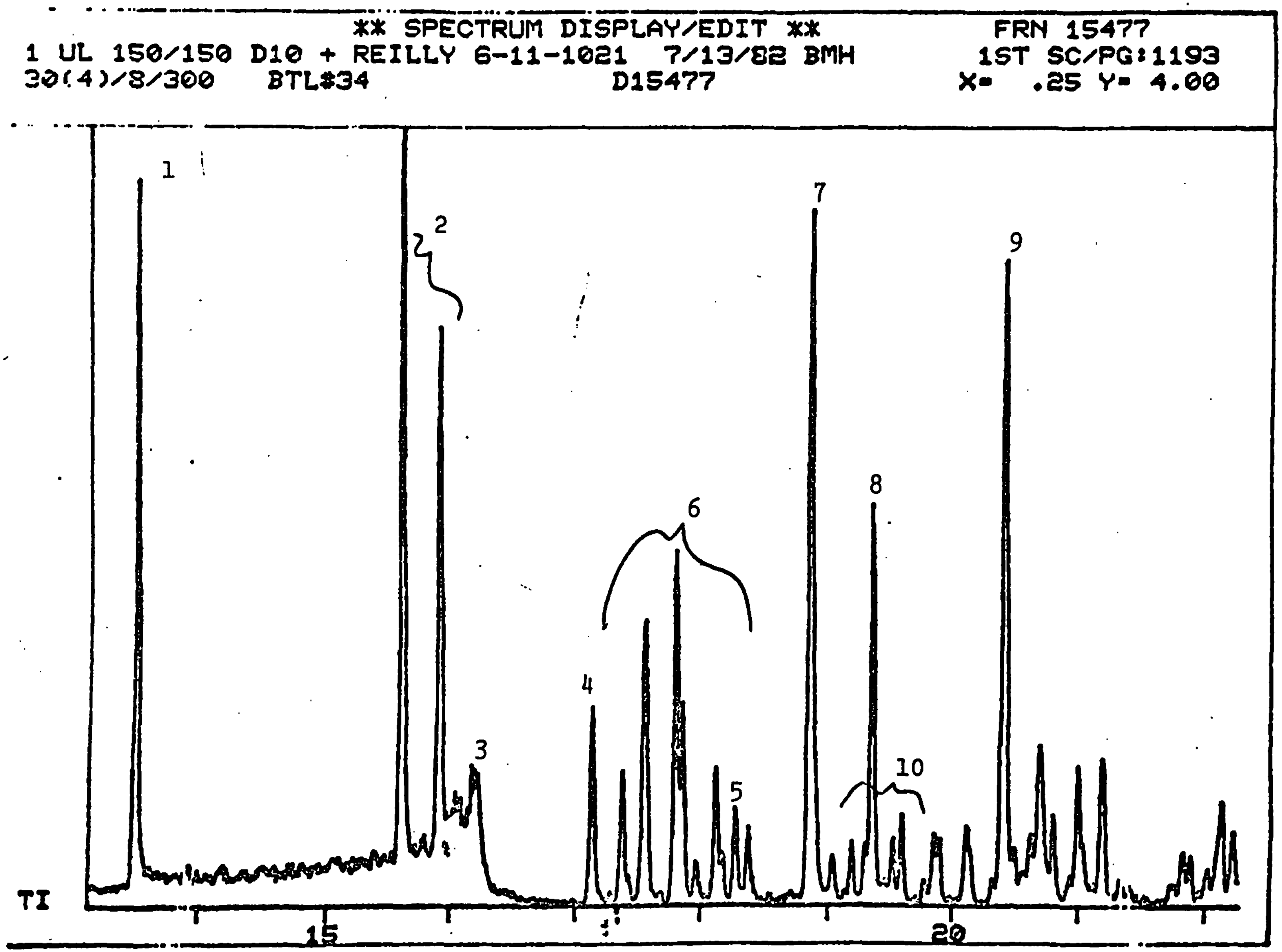


Figure 1. Total ion chromatogram obtained from the capillary GC/MS analysis of a tar sample from Well 23. See Table 1 for the identifications of numbered peaks.

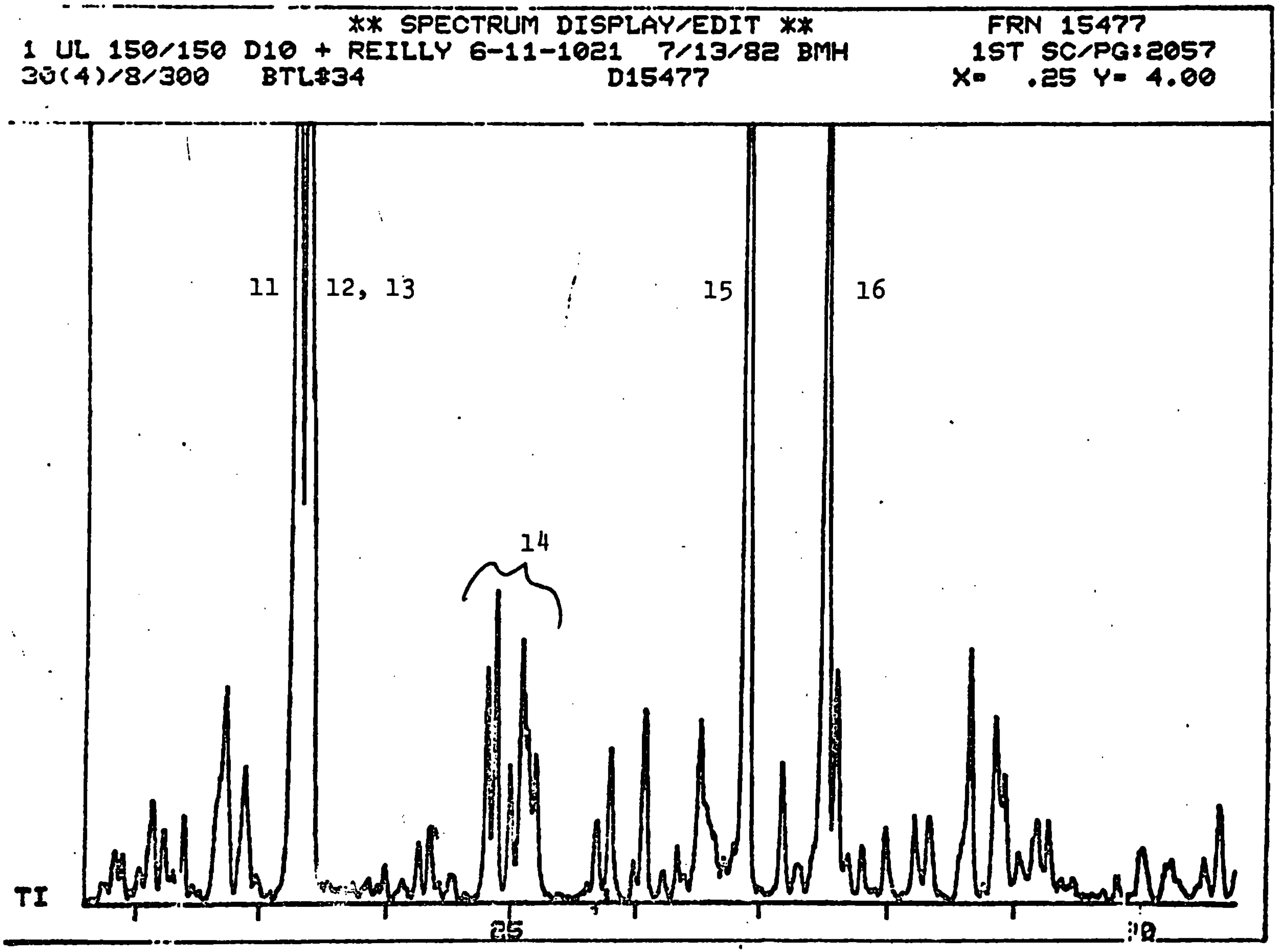


Figure 1. (cont'd)

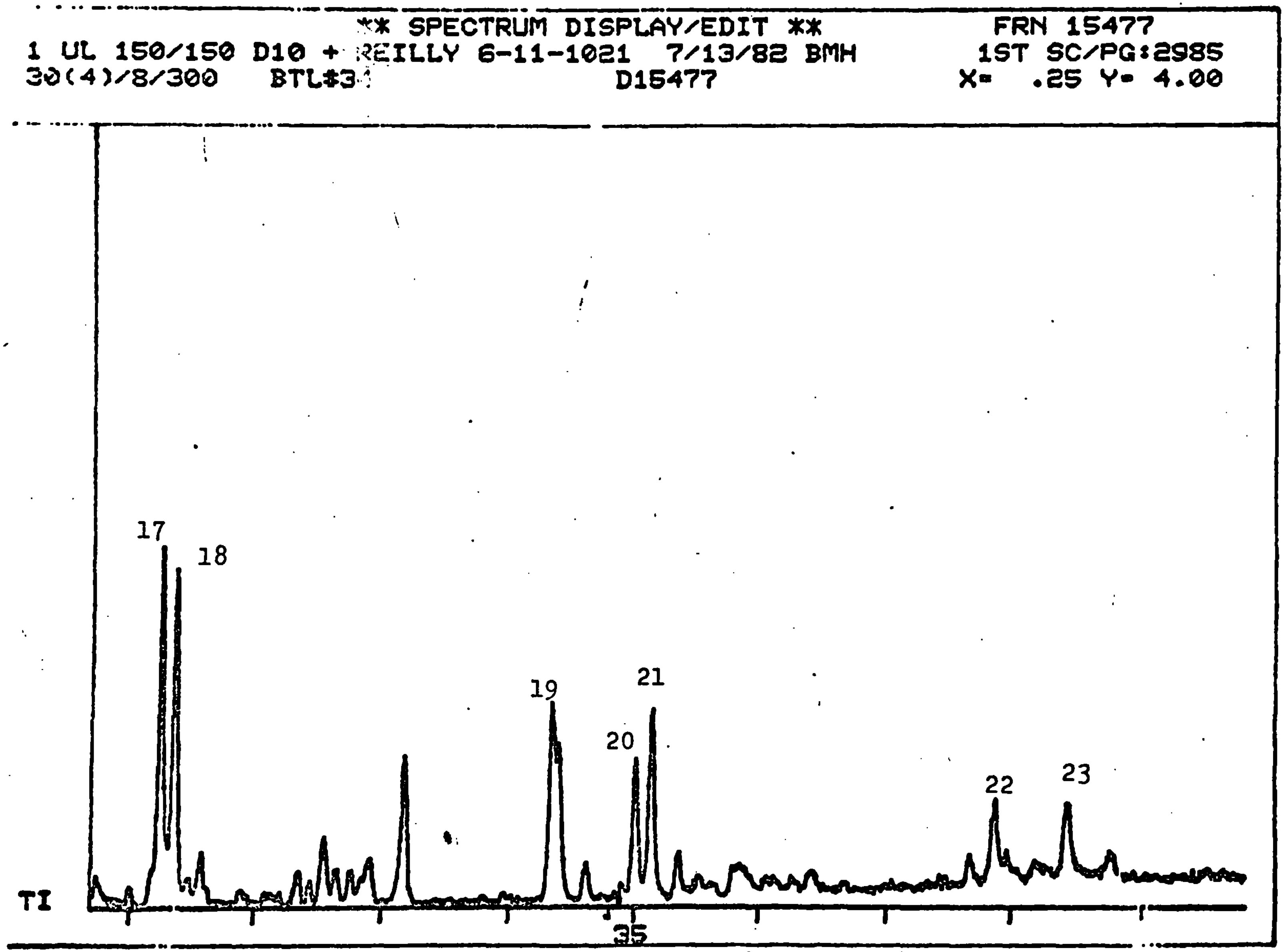


Figure 1. (cont'd)

408593

TABLE 1. MAJOR COMPONENTS IDENTIFIED IN WELL 23 TAR SAMPLE NO. 6-11-1021, SHOWN ANALYZED IN FIGURE 1.

Peak No.	Compound Name	Concentration (mg/g)[a]		MRI Results (mg/g)
1	Naphthalene	7.8		8.8
2	Methylnaphthalene isomers	10.8		NR[c]
3	N,N-diethyl-benzamine	(possible impurity)		
4	Acenaphthalene	2.1		5.8
5	Acenaphthalene	1.4		1.7
6	Dimethylnaphthalene isomers	8.5		NR
7	Dihydroacenaphthalene	4.8		NR
8	Dibenzofuran	5.1		NR
9	Fluorene	6.0		7.9
10	Trimethylnaphthalene isomers	2.9		NR
11	Phenanthrene	23.3	b	27
12	Anthracene-d_{10} (IS)	17.5		-
13	Anthracene	4.0		NR
14	Methylphenanthracene and/or anthracene isomers	8.4		NR
15	Fluoranthene	18.2		21
16	Pyrene	15.3		14
17	Benzo(a)anthracene	3.3	b	-
18	Chrysene	3.6		6.8
19	Isomer of Benzo(a)pyrene	4.1	b	17
20	Isomer of Benzo(a)pyrene	1.3		
21	Benzo(a)pyrene	2.0		5.9
22	Indeno (1,2,3,cd)pyrene	1.2	b	
23	Benzo(g,h,i)perylene	1.1		3.9

[a] Estimated by comparing molecular ion responses to that of the internal standard (anthracene-d_{10}).

[b] Possibly sum of these two isomers are reported in MRI study.

[c] Not reported in MRI study.

7-09-82
N.

MONSANTO RESEARCH CORPORATION *Inter-Office Correspondence*

From LOCATION : B. M. Hughes, Dayton Laboratory
(513) 268-3411 (ext. 436, 409, 209)

DATE : 9 July 1982

SUBJECT : Analysis Request Forms Received - 215.45718

REFERENCE : U.S.A. v. Reilly Tar & Chemical Corporation

CC : John C. Craun/ERT
Jerry R. Rick/SEC
J. J. Brooks

TO : Edward J. Schwartzbauer
Dorsey, Windhorst, Hannaford, Whitney, & Halladay
2200 First Bank Place East
Minneapolis, Minnesota 55402

REC'D JUL 13 1982

Enclosed are copies of analytical request forms which have been submitted for the analysis of samples received in conjunction with the project referenced above. MRC has assigned a unique log number for each set of samples and has outlined the requested analyses on the enclosed analytical request forms. If any incorrect information is included on the enclosed forms, please notify me immediately.

B. M. Hughes

B. M. Hughes

BMH/cvd

408595

RC-10

ANALYSIS REQUEST | DATE 6/29/82 | LOG NO. 1-82-06-29-01

MONSANTO RESEARCH CORPORATION
DAYT LABORATORY

REQUESTER** Reilly TAR / Soil Expl.

CHARGE NO.** 215.45718

REPORT RESULTS TO FILES / KULIK
Brooks
Gridley
M. Johnson

SAMPLE DESCRIPTION   NUMBER OF BOTTLES: 1   NUMBER OF SAMPLES ** 1

Sample # 6/28/9:75   Composite

Original Chain of Custody to Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST FILES
Brooks
Gridley
A.M. Hughes
M. Johnson

SAMPLES FOR: Hughes

SAMPLE LOCATION 1-21 FREEZER

REQUIRED ANALYSIS**

GC/MS Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ____ SEMIQUANT. ____ QUANT. ____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE   ☐ DISCARD   ☐ RETURN   HOLD FOR ☐ 30 DAYS   ☐ 60 DAYS   Hold OT

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

105596

SAMPLE TRANSMITTAL LETTER

Client REILLY TAR & CHEM Project Title [illegible]

Date Shipped [illegible] Shipped by [illegible]

Shipped From [illegible]

Shipped To [illegible] Attention of [illegible]

Additional Shipping Information or Comments [illegible]

Sample Description Code

~~Comments~~

	COMMENTS:
6/22/9:75.	[illegible]
OW 23 [illegible]	
SAMPLE FROM [illegible]	
TAKEN FROM [illegible]	
R.L.O./SEC. [illegible]	

Samples Received by Alan H Ford

Date Samples Received 6/29/82 tape "seal" intact

Return Letter Received by Contract Laboratory ____ Date ____

MRC-QA #001T
061082lh

408597

ANALYSIS REQUEST DATE 28 LOG NO. -82-07-02-0

MONSANTO RESEARCH CORPORATION REQU TER** —

DAYT LABORATORY

CHARGE NO.** 215.45 8

REPORT RESULTS TO

FILES/KULIK

Brooks

Guidlee

MPLE DESCRIPTION NUMBER OF F LES** 5 NUMBER OF SAMPLES ** 5

6/30/8:20 - Depth 653 from Bailer

6/30/10:00 - Depth 655'

6/30/14:00 - Depth 663½

7/1/10:50 - Depth 666-680

7/1/13:50 - Depth 680'

ANALYSIS REQUEST

FILES

M

SAMPLES FOR:

Hughes

SAMPLE LOCATION

1-21

RECORDED BY:

REQUIRED ANALYSIS** GC/MS Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold

B. M. Hughes

SAMPLE TRANSMITTAL LETTER

120-8820

Client REILLY TAR + CHEM CORP Project Title REILLY TAR + CHEM CORP ST LOUIS PARK, MN

Date Shipped 7/1/82 Shipped by [illegible] Soil Exploration Company

Shipped From Soil Exploration Company [illegible] ST PAUL MN 55114

Shipped To MONSANTO RESEARCH CORPORATION Attention of JOE BROOKS

Additional Shipping Information or Comments PACKED WITH 5 lbs DRY ICE

Sample Description Code	COMMENTS:
~~[illegible]~~	
6/30/8:20	SAND & GRAVEL FROM BAILER W/TAR DEPTH > [illegible]
6/30/10:00	TARRY SAND & GRAVEL (COARSE MATERIAL) [illegible] DEPTH > [illegible]
6/30/14:00	SAND & GRAVEL W/TAR DEPTH > [illegible]
7/1/10:50	TARRY SUBSTANCE BROWN MATERIAL (DIF[illegible] DEPTH > [illegible] FROM BAILER
7/1/12:50	TARRY SUBSTANCE MORE REPRESENTATIVE OF [illegible] FROM BAILER
	[illegible] 7/1/12:50 SAMPLE WAS NOT [illegible] WITH [illegible] [illegible] HICKOK AND ASSOCIATES

Samples Received by Francine A. Kelich

Date Samples Received 7/2/82

Return Letter Received by Contract Laboratory ________ Date ______

MRC-QA #001T
061082lh

408599

ANALYSIS REQUEST | DATE 7/7/82 | LOG NO. 1-82-07-07-01

MONSANTO RESEARCH CORPORATION
DAYT LABORATORY

REQUESTER** Reilly TAR & Chem.

CHARGE NO.** 215.45718

REPORT RESULTS T
FILES/KULIK
Brooks
Gridley
Johnson

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 1 NUMBER OF SAMPLES ** 1

7/2/9:15 OW 23 St. Louis Park, MN
Bailer SAMPLE
Depth 685'

Original Chain of Custody to Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST FILES
Brooks
Gridley
B.M. Hughe
M. Johnson

SAMPLES FOR:
Hughes

SAMPLE LOCATION
1-21
Freezer

REQUIRED ANALYSIS** GC/MS Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ____________

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OT

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

SAMPLE TRANSMITTAL LETTER

Client REILLY TAR Project Title REILLY TAR CW 23 ST LOUIS PARK, MN

Date Shipped 7-2-82 Shipped by Ross Olmon Soil Exploration Company

Shipped From Soil Exploration Company 662 Cromwell Ave St Paul, MN

Shipped To: Monsanto ~~Central~~ (Research) Corporation Attention of Joe Brooks

Additional Shipping Information or Comments PACKED WITH DRY ICE, SAMPLE MAY CONTAIN HAZARDOUS WASTE!

Sample Description Code	COMMENTS:
~~Comments~~	
7/2/9:15	
CW 23 ST LOUIS PARK, MN	BLACK TARRY SUBSTANCE, SAND WITH SOME STONES.
BAILER SAMPLE	
DEPTH → 685'	Ross L. Olman

Samples Received by Alan H. Ford (seal intact)

Date Samples Received 7/6/82

Return Letter Received by Contract Laboratory ______ Date ______

MRC-QA #001T
0610821h

408001

6-24-82.

MONSANTO RESEARCH CORPORATION *Inter-Office Correspondence*

From: B. M. Hughes/Dayton Laboratory
(513) 268-3411 (Ext. 436, 409, 209)

cc: William Gregg/ERT
Jerry R. Rick/SEC
J. J. Brooks/MRC

DATE: 24 June 1982

SUBJECT: Analysis Request Forms Received - 215.45718

REFERENCE: U.S.A. v. Reilly Tar & Chemical Corporation

Chain-of-Custody/Sample Logs
6/14/82 - 6/29/82
(W23 work included)

TO [redacted]
Dorsey, Windhorst, Hannaford, Whitney, & Hallada
2200 First Bank Place East
Minneapolis, Minnesota 55402

Enclosed are copies of analytical request forms which have been submitted for the analysis of samples received in conjuction with the project referenced above. MRC has assigned a unique log number for each set of samples and has outlined the requested analyses on the enclosed analytical request forms. If any incorrect information is included on the enclosed forms, please notify me immediately.

B. M. Hughes

B. M. Hughes

409567

RC-10

ANALYSIS REQUEST	DATE 6/14/82	LOG NO. 1-82-06-14-06	REPORT RESULTS TO: FILES/KULIK Brooks Gridley M. HUGHES

MONSANTO RESEARCH CORPORATION DAYTON LABORATORY

REQUESTER** J. Brooks/Reilly T&C

CHARGE NO.** 215. SEE BELOW

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 4 NUMBER OF SAMPLES ** 4

W 023 6-11-82 Casing Shavings

W 023 6-11-1116 Core from well

W023 6-11-82 Acetone Rinse

W023 6-11-1021 Core from well

RECORDED BY: A. Ford

ANALYSIS REQUEST TO: FILES Brooks Gridley ~~M. Johnson~~ M. HUGHES

SAMPLES FOR: M. Hughes

SAMPLE LOCATION 1-21 Freezer

REQUIRED ANALYSIS** * NOTE: HOLD ANALYSES FOR COMPARABLE ANALYTICAL INFORMATIO[N] FROM CUSTOMER

215. 45718 — GC/ms
215. 45725 — ADMINISTRATIVE

Original Chain of Custody to: J. Gridley

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☒ GC/MS
- ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

REQUIRED QA/QC

— FULL PROGRAM

— WORK IS UNDER LITIGATION

— ALL PROCEDURES AND CONTROLS MUST BE CAPABLE OF STANDING [UP] IN COURT

409568

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS ✓ OTH[ER] INDEFINIT[E]

SAMPLE TRANSMITTAL LETTER

Client Reilly Tar & Chem Project Title CW-23 Investigation

Date Shipped 6/10/82 Shipped by Jerry Rick, SEC

Shipped From St. Louis Park, MN

Shipped To Monsanto Research Attention of Joe Brooks

Additional Shipping Information or Comments Samples were sealed in cooler at St. Louis Park and given to Mark Johnson to return with him on his plane flight

Sample Description Code

~~Comments~~

Log #	Comments
W 023 6-11-1021	Core Sampler Scrapings @ 574'
W 023 6-11-82 Acetone Rinse	Rinse From Tools
W 023 6-11-1116	Core Sampler Scrapings @ 575'
W023 6-11-82 Casing Shavings	Shavings off USCS 4" casing laying in Reunion yard in Harsea

Samples Received by Alan H. Ford - seal tape intact.

Date Samples Received 6/14/82 10:30 A.M.

Return Letter Received by Contract Laboratory ______ Date ______

MRC-QA #001T
061082lh

ANALYSIS REQUEST | DATE 6/24/82 | LOG NO. 1-82-06-24-02

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** Reilly TAR

CHARGE NO.** 215.45718

REPORT RESULTS FILES /KULIK
Gridley
M. Johnson
J. Brooks

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 1 NUMBER OF SAMPLES ** 1

6-18-14:42 fine, white sand with tar substance within.

Original chain of custody to J. Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST FILES
Gridley
M. Johnson
B.M. Hughes
Brooks

SAMPLES FOR:
M. Hughes

SAMPLE LOCATION
1-21
FREEZER

REQUIRED ANALYSIS**

GC/MS - HOLD Analysis.

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **
1-82-06-18-01
1-82-06-14-06

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL ____ SEMIQUANT. ____ QUANT. ____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

409570

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS ✓ 0

CHAIN OF CUSTODY

PROJECT REILLY TAR & CHEM

LOCATION ST. LOUIS PARK MN.

	SAMPLE NUMBER	DATE COLLECTED
1.	618 1442 WHITE FINE SAND, WITH TAR SUBSTANCE WITHIN	6-18-82
2.		
3.		
4.		
5.		
6.		
7.		

DATE SAMPLED 6-18-82

SHIPPED BY [signature]

METHOD OF SHIPMENT FEDERAL EXPRESS

DATE RECEIVED 6/23/82

RECEIVED BY Alan H Ford

COMMENTS Seal tape intact.

ANALYSIS REQUEST | DATE 6/18/82 | LOG NO. 1-82-06-18-01

REPORT RESULTS TO: FILES/KULIK
J. Brooks
Gridley
M. Hughes

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER**: Reilly Tar/Brooks

CHARGE NO.**: SEE BELOW

SAMPLE DESCRIPTION NUMBER OF BOTTLES 5 NUMBER OF SAMPLES ** 5

#615900
#615930
#6151000
#6151020
#6171442

Chain of Custody to Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST FILES
Brooks
M. Hughes
Gridley
M. Tc...

SAMPLES FOR: Hughes

SAMPLE LOCATION: 1-21 FREEZER

REQUIRED ANALYSIS** * NOTE: ... ANALYTICAL WORK F... CONF... ANALYTICAL APPROACH/TASK FROM CUSTOMER.

215.45718 - GC/...
215.45725 - ... ALTERNATIVE

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **:

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☒ GC/MS
- ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC
- FULL ...
• WORK IS ...
• ALL PROCEDURES ... MUST BE CAPABLE OF ...

409572

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold

... ORIGINATOR

CHAIR OF CUSTODY

Project Rem-Tar

Location St. Louis Pa

SAMPLE NUMBER	DATE COLLECTED
1. 615900	6/15/82
2. 615930	6/15/82
3. 6151000	6/15/82
4. 6151020	6/15/82
5. 6171442	6/17/82
6.	
7.	

Date Shipped 6/17/82

Shipped By [illegible] Rick, SEC

Method of Shipment Federal Express

Date Recieved 6/18/82

Received By Alan H Ford "seal intact"

Comments

409573

7-09-82

MONSANTO RESEARCH CORPORATION *Inter-Office Correspondence*

From LOCATION : B. M. Hughes, Dayton Laboratory
(513) 268-3411 (ext. 436, 409, 209)

DATE : 9 July 1982

CC: John C. Craun/ERT
Jerry R. Rick/SEC
J. J. Brooks

SUBJECT : Analysis Request Forms Received - 215.45718

REFERENCE : U.S.A. v. Reilly Tar & Chemical Corporation

REC'D JUL 13 1982

TO : Edward J. Schwartzbauer
Dorsey, Windhorst, Hannaford, Whitney, & Halladay
2200 First Bank Place East
Minneapolis, Minnesota 55402

Enclosed are copies of analytical request forms which have been submitted for the analysis of samples received in conjunction with the project referenced above. MRC has assigned a unique log number for each set of samples and has outlined the requested analyses on the enclosed analytical request forms. If any incorrect information is included on the enclosed forms, please notify me immediately.

B. M. Hughes

B. M. Hughes

BMH/cvd

408595

RC-10

ANALYSIS REQUEST	DATE 6/29/82	LOG NO. 1-82-06-29-01	REPORT RESULTS TO** FILES/KULIK Brooks Gridley M. Johnson

MONSANTO RESEARCH CORPORATION DAYTON LABORATORY	REQUESTER** Reilly TAR/Soil Expl.	CHARGE NO.** 215.45718

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 1 NUMBER OF SAMPLES ** 1

Sample # 6/28/9:75 Composite

Original Chain of Custody to Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST TO FILES Brooks Gridley B.M. Hughes M. Johnson

SAMPLES FOR: Hughes

SAMPLE LOCATION 1-21 FREEZER

REQUIRED ANALYSIS**

GC/MS Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ______________

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OTHER

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

408596

SAMPLE TRANSMITTAL LETTER

Client REILLY TAR + CHEM Project Title

Date Shipped Shipped by

Shipped From

Shipped To Attention of

Additional Shipping Information or Comments

Sample Description Code

~~Comments~~

COMMENTS:

6/28/9:75

OW ~~#~~ 23

SAMPLE FR

TAKEN FROM

R.L.C. /SEC.

Samples Received by Alan H Ford

Date Samples Received 6/29/82 tape "seal" intact

Return Letter Received by Contract Laboratory Date

MRC-QA #001T
061082lh

408597

ANALYSIS REQUEST | DATE 7/2/82 | LOG NO. 1-82-07-02-01

MONSANTO RESEARCH CORPORATION
DAYT LABORATORY

REQUESTER** Reilly Tar + Chem
CHARGE NO.** 215.45718

REPORT RESULTS TO* FILES/KULIK
Brooks
Gridley
M Johnson

SAMPLE DESCRIPTION NUMBER OF BOTTLES* 5 NUMBER OF SAMPLES ** 5

6/30/8:20 - Depth 653 from Bailer
6/30/10:00 - Depth 655 "
6/30/14:00 - Depth 663½
7/1/10:50 - Depth 666-680
7/1/13:50 - Depth 680'

RECORDED BY: F.O. Kulik

ANALYSIS REQUEST T
FILES
Gridley
Brooks
BM Hughes
M Johnson

SAMPLES FOR:
Hughes

SAMPLE LOCATION
1-21 Fr
Freezer

REQUIRED ANALYSIS** GC/MS Hold analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ____
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ____ SEMIQUANT. ____ QUANT. ____

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OT

B. M. Hughes

SAMPLE TRANSMITTAL LETTER

120-8820

Client REILLY TAR + CHEM CORP **Project Title** REILLY TAR + CHEM CORP ST LOUIS PARK, MN

Date Shipped 7/1/82 **Shipped by** [illegible] SOIL EXPLORATION COMPANY

Shipped From SOIL EXPLORATION COMPANY [illegible] ST PAUL MN 55114

Shipped To MONSANTO RESEARCH CORPORATION **Attention of** JOE BROOKS

Additional Shipping Information or Comments PACKED WITH 5 lbs DRY ICE

Sample Description Code	COMMENTS:
~~Comments~~	
6/30/8:20	SAND & GRAVEL FROM BAILER W/TAR DEPTH > 60'
6/30/10:00	TARRY SAND & GRAVEL (COARSE MATERIAL) [illegible] DEPTH > 60'
6/30/14:00	SAND & GRAVEL W/TAR DEPTH > 60'
7/1/10:50	TARRY SUBSTANCE - BROWN MATERIAL (DIFF DEPTH > 60' - FROM BAILER
7/1/12:50	TARRY SUBSTANCE MOST REPRESENTATIVE OF [illegible] - FROM BAILER
	[illegible] 7/1/12:50 SAMPLE WAS NOT INVOLVED WITH [illegible] [illegible] AND ASSOCIATES

Samples Received by Francine A. Kelik

Date Samples Received 7/2/82

Return Letter Received by Contract Laboratory ______ **Date** ______

MRC-QA #001T
061082lh

408599

ANALYSIS REQUEST | DATE 7/7/82 | LOG NO. 1-82-07-07-01

MONSANTO RESEARCH CORPORATION
DAYT LABORATORY

REQUESTER** Keilly TAR & Chem.

CHARGE NO.** 215.45718

REPORT RESULTS TO FILES/KULIK
Brooks
Gridley
Johnson

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 1 NUMBER OF SAMPLES ** 1

7/2/9:15 OW 23 St. Louis Park, MN
Bailer SAMPLE
Depth 685'

Original Chain of Custody to Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST TO FILES
Brooks
Gridley
B.M. Hughes
M. Johnson

SAMPLES FOR: Hughes

SAMPLE LOCATION
1-21
Freezer

REQUIRED ANALYSIS** GC/MS Hold Analysis

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold OTHER

** THIS INFORMATION MUST BE SUPPLIED BY ANALYSIS REQUEST ORIGINATOR

4C5530

SAMPLE TRANSMITTAL LETTER

Client REILLY TAR Project Title REILLY TAR OW 23 ST LOUIS PARK, MN

Date Shipped 7-2-82 Shipped by Ross Chimon Soil Exploration company

Shipped From Soil Exploration company 662 Cromwell Ave ST PAUL, MN

Shipped To: MONSANTO ~~RESEARCH~~ (RESEARCH) CORPORATION Attention of JOE BROOKS

Additional Shipping Information or Comments PACKED WITH DRY ICE, SAMPLE MAY CONTAIN HAZARDOUS WASTE!

Sample Description Code

~~Comments~~

1/2/9:15	COMMENTS:
OW 23 ST LOUIS PARK, MN	BLACK TARRY SUBSTANCE, SAND WITH SOME STONES.
BAILER SAMPLE	Ross L. Chimon
DEPTH → 685'	

Samples Received by Alan H. Ford (seal intact)

..te Samples Received 7/6/82

..turn Letter Received by Contract Laboratory ________ Date ________

MRC-QA #001T
061082lh

408601

N.

6-24-82.

MONSANTO RESEARCH CORPORATION

Inter-Office Correspondence

From Location : B. M. Hughes/Dayton Laboratory
(513) 268-3411 (Ext. 436, 409, 209)

Date : 24 June 1982

cc : William Gregg/ERT
Jerry R. Rick/SEC
J. J. Brooks/MRC

Subject : Analysis Request Forms Received - 215.45718

Reference : U.S.A. v. Reilly Tar & Chemical Corporation

TO [redacted]
Dorsey, Windhorst, Hannaford, Whitney, & Halladay
2200 First Bank Place East
Minneapolis, Minnesota 55402

Enclosed are copies of analytical request forms which have been submitted for the analysis of samples received in conjuction with the project referenced above. MRC has assigned a unique log number for each set of samples and has outlined the requested analyses on the enclosed analytical request forms. If any incorrect information is included on the enclosed forms, please notify me immediately.

B. M. Hughes

B. M. Hughes

409567

RC-10

ANALYSIS REQUEST | DATE 6/14/82 | LOG NO. 1-82-06-14-06

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** J. Brooks/Reilly T&C

CHARGE NO.** 215. SEE BELOW

REPORT RESULTS TO: FILES/KULIK Brooks Gridley M. HUGHES

SAMPLE DESCRIPTION | NUMBER OF BOTTLES: 4 | NUMBER OF SAMPLES **4

W 023 6-11-82 Casing Shavings

W 023 6-11-1116 Core from well

W023 6-11-82 Acetone Rinse

W023 6-11-1021 Core from well

RECORDED BY: A. Ford

ANALYSIS REQUEST FILES: Brooks Gridley ~~M. Johnson~~ M. HUGHES

SAMPLES FOR: M. Hughes

SAMPLE LOCATION: 1-21 Freezer

REQUIRED ANALYSIS** * NOTE: HOLD ANALYSES FOR COMPARABLE ANALYTICAL INFORMAT[ION] FROM CUSTOMER

215. 45718 — GC/MS
215. 45725 — ADMINISTRATIVE

Original Chain of Custody to J. Gridley

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTION
- ☐ MASS SPEC
- ☒ GC/MS
- ☐ AUTO ANALYZER

QUAL. ______ SEMIQUANT. ______ QUANT. ______

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC
— FULL PROGRAM
— WORK IS UNDER LITIGATION
— ALL PROCEDURES AND CONTROLS MUST BE CAPABLE OF STANDING IN COURT

409568

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS ✓ OT[HER] INDEFINI[TELY]

SAMPLE TRANSMITTAL LETTER

Client Reilly Tar & Chemical Project Title OW-23 Investigation
Date Shipped 6/10/82 Shipped by Jerry Rick, SEC
Shipped From St. Louis Park, MN
Shipped To Monsanto Research Attention of Joe Brooks
Additional Shipping Information or Comments Samples were sealed in cooler at St. Louis Park and given to Mark Johnson to return with him on his plane flight

Sample Description Code
~~Comments~~

Log #	Comments
W 023 6-11-1021	Core Sampler Scrapings @ 574'
W 023 6-11-82 Acetone Rinse	Rinse From Tools
W 023 6-11-1116	Core Sampler Scrapings @ 575'
W023 6-11-82 Casing Shavings	Shavings off USCS 4" casing laying in [illegible]

Samples Received by Alan H. Ford - seal tape intact.
Date Samples Received 6/14/82 10:30 A.M.
Return Letter Received by Contract Laboratory ____ Date ____

MRC-QA #001T
061082lh

409569

ANALYSIS REQUEST | DATE 6/24/82 | LOG NO. 1-82-06-24-02

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** Reilly TAR

CHARGE NO:** 215.45718

REPORT RESULTS TO: FILES/KULIK
Gridley
M. Johnson
J. Brooks

SAMPLE DESCRIPTION NUMBER OF BOTTLES: 1 NUMBER OF SAMPLES ** 1

6-18-14:42 fine, white sand with tar substance within.

Original chain of custody to J. Gridley

RECORDED BY: A. Ford

ANALYSIS REQUEST TO: FILES
Gridley
M. Johnson
B.M. Hughes
Brooks

SAMPLES FOR: M. Hughes

SAMPLE LOCATION: 1-21 FREEZER

REQUIRED ANALYSIS**

GC/MS - HOLD Analysis.

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **
1-82-06-18-01
1-82-06-14-06

COMPLETION DATE ______

ANALYTICAL TECHNIQUE **

- ☐ GAS CHROMATOGRAPHY
- ☐ ULTRAVIOLET
- ☐ VISIBLE
- ☐ INFRARED
- ☐ EMISSION
- ☐ EDAX XRF
- ☐ MICROSCOPY
- ☐ OTHER ______
- ☐ NMR
- ☐ HPLC
- ☐ XRD
- ☐ ICP
- ☐ ATOMIC ABSORPTIO
- ☐ MASS SPEC
- ☐ GC/MS
- ☐ AUTO ANALYZER

QUAL. ____ SEMIQUANT. ____ QUANT. ____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

409570

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS ✓

CHAIN OF CUSTODY

PROJECT REILLY TAR & CHEM

LOCATION ST. LOUIS PARK MN.

	SAMPLE NUMBER		DATE COLLECTED
1.	6181442	WHITE FINE SAND, WITH TAR SUBSTANCE WITHIN	6-18-82
2.			
3.			
4.			
5.			
6.			
7.			

DATE SAMPLED 6-18-82

SHIPPED BY [signature]

METHOD OF SHIPMENT FEDERAL EXPRESS

DATE RECEIVED 6/23/82

RECEIVED BY Alan H Ford

COMMENTS Seal tape intact.

409571

ANALYSIS REQUEST | DATE 6/19/82 | LOG NO. 1-82-06-18-01

MONSANTO RESEARCH CORPORATION
DAYTON LABORATORY

REQUESTER** Reilly Tar / Brooks

CHARGE NO.** SEE BELOW

REPORT RESULTS TO:
FILES/KULIK
J. Brooks
Gridley
M. HUGHES

SAMPLE DESCRIPTION

NUMBER OF BOTTLES 5

NUMBER OF SAMPLES ** 5

#615900
#615930
#6151000
#6151020
#617/412

ANALYSIS REQUEST TO:
FILES
Brooks
M. Hughes
Gridley
M. T[illegible]

SAMPLES FOR:
Hughes

Chain of Custody to Gridley

RECORDED BY: A. Ford

SAMPLE LOCATION
1-21
FREEZER

REQUIRED ANALYSIS** * NOTE: [illegible] ANALYTICAL WORK [illegible] CONF[illegible] [illegible] ANALYTICAL APPROACH/TASK [illegible] CUSTOMER.

215.45718 - GC/[illegible]
215.45725 - [illegible] ALTERNATIVE

KNOWN HEALTH HAZARD PRESENTED BY SAMPLE: **

REFERENCE TO PREVIOUS WORK (REQUEST #, JOURNAL, ETC.) **

COMPLETION DATE ____________

ANALYTICAL TECHNIQUE **

- [ ] GAS CHROMATOGRAPHY
- [ ] ULTRAVIOLET
- [ ] VISIBLE
- [ ] INFRARED
- [ ] EMISSION
- [ ] EDAX XRF
- [ ] MICROSCOPY
- [ ] OTHER ______
- [ ] NMR
- [ ] HPLC
- [ ] XRD
- [ ] ICP
- [ ] ATOMIC ABSORPTION
- [ ] MASS SPEC
- [x] GC/MS
- [ ] AUTO ANALYZER

QUAL. _____ SEMIQUANT. _____ QUANT. _____

TIME ALLOTED FOR ANALYSES

ANALYST	HOURS	INST. TIME

REQUIRED QA/QC

- FULL [illegible]
- [illegible]
- ALL PROCEDURES [illegible] MUST BE CAPABLE OF [illegible]

409572

**SAMPLE DISPOSAL: AFTER REPORT COMPLETE ☐ DISCARD ☐ RETURN HOLD FOR ☐ 30 DAYS ☐ 60 DAYS Hold

** ORIGINATOR [illegible]

CHAIR OF CUSTODY

Project Renu-Tar

Location St. Louis Co

SAMPLE NUMBER	DATE COLLECTED
1. 615900	6/15/82
2. 615930	6/15/82
3. 6151000	6/15/82
4. 6151020	6/15/82
5. 6171442	6/17/82
6.	
7.	

Date Shipped 6/17/82

Shipped By Larry Rick, SEC

Method of Shipment Federal Express

Date Recieved 6/18/82

Received By Allan H Ford "seal intact"

Comments

409573

6/15/82
/N.

Heikok Output File

1982

Minnesota Pollution Control Agency

June 15, 1982

Mr. George W. Boyer, P.E.
E. A. Hickok and Associates, Inc.
545 Indian Mound
Wayzata, Minnesota 55391

Dear Mr. Boyer:

Thank you for your submittal of July 9, 1982 regarding progress on the St. Louis Park Well Abandonment Program. I have several comments on your submittal, as follows:

1. Copies. Please delete Mr. Jim Pankanin, USEPA, Chicago, from your list of people to receive copies, and substitute Mr. Paul Bitter, same address. I will send Mr. Bitter a copy of this submittal, and I apologize for not noting this change earlier.

2. Well 23. The Minnesota Pollution Control Agency (Agency) understands that work on Well 23 has progressed much slower than anticipated and that a number of difficulties have been encountered. There were a number of inconsistencies and omissions in your progress report, however, which we would like your comments on:

   a. Starting depth. You indicate that creosote was encountered at an initial depth of 567.8. My notes from the 11th of June indicated that creosote was encountered at 574. Please explain.

   b. The progress report did not detail that fibers were found at one point and that, in fact, the borings were almost clean sand just prior to the point where the split spoon sampler was lost. I would hope that your field notes are, and final report would be, much more detailed than your progress report is. I would prefer that such significant details be reported in future progress reports.

Phone:____________
1935 West County Road B2, Roseville, Minnesota 55113-2785
Regional Offices • Duluth/Brainerd/Detroit Lakes/Marshall/Rochester
Equal Opportunity Employer

c. Depth 601. Your progress report indicates that a depth of 601 was reached on Friday, June 11, 1982. Then, on Monday, June 14, drilling began at a depth of 593. Please explain.

3. Search and Inventory. Your Detailed Work Plan indicated that the door-to-door survey would being July 23, 1982. Subsequent discussions with the city fixed that date to July 21, 1982, and significant community relations efforts have been started using that date. Please do not start the survey until July 21, 1982 as we discussed, so that the survey will more effectively mesh with other activities. In the future, please do not move any activities ahead in the schedule without notifying the Agency ahead of time. I do not regard a notice which I receive on the day that activity will start as prior notice.

4. Expenditures

a. Expenses. Expenses will be approved as noted.

b. Engineering Costs - Well 23. Certain engineering costs are in excess of the amount spelled out in the contract and will not be approved. Specifically, page 15 of the contract provides for the following engineering costs:

1) Field geologist 173 hours at $36.00 per hour

6) Interaction with state 10 hours at $78.00 per hour

Therefore, I will approve the following engineering costs:

144.5 hours at $36.00 per hour = 5,202.00

10 hours at $78.00 per hour = 780.00

TOTAL = 5,982.00

The remaining costs of $5,593.80 are not authorized in the contract, were not authorized prior to expenditure as provided on page 13 of the contract, and will not be approved.

It is apparent that additional time will be needed for the field geologist and for interaction. Please estimate the additional time necessary, and inform us as soon as possible, so that the contract can be amended, if necessary.

c. Engineering Costs - Search and Inventory. Engineering costs will be approved as noted. However, the hourly rates do not match the rates in the contract. Please explain.

Mr. George W. Boyer, P.E
Page Three

5. Delinquency. Every major item of work and report on this project have been late by several days to a week. While some of this delay has been due to circumstances beyond your control (e.g. work on Well 23), submission of the detailed work plan, submission of the first progress report, and response to my letter of June 17 have been delinquent. This is not satisfactory. In the future, please be more timely in your interactions with this office.

I would be happy to discuss this matter with you at your earliest convenience.

Sincerely,

Michael J. Hansel
Regulatory Compliance Section
Solid and Hazardous Waste Division

MJH/dc

cc. Paul Bitter, U.S. Environmental Protection Agency

Dress / Paul B

The University of Iowa

Iowa City, Iowa 52242

University Hygienic Laboratory

(319) 353-5990

1847

RECEIVED JUL 23 1982

20 July 1982

E.A. Hickok and Associates
545 Indian Mound
Wayzata, MN 55391

Attn: Mr. George Boyer

RE: UHL #2-2346

Dear George:

Attached are the results of the "soil" analysis from St. Louis Park. As discussed with Ms. Patt Cain the sample was split into three fractions by dissolving the sample in dichloromethane (85% soluble) and extracting with acid (1% soluble) and then base (1% soluble). All compounds identified are at concentrations greater than 10 ppm.

Sincerely,

Armand F. Lange, Ph.D.

Armand F. Lange, Ph.D.
Chief, Organic Analytical Division

lm

enclosure

cc: Dr. Splinter
Dr. Hahne
Ms. Cain
Mr. Brewer
File

Qualitative Analysis
Sample 2-2346
Acid Extract

Scan #	Compound
826	Naphthalene
962	2-Methyl naphthalene
982	1-Methyl naphthalene
979	2-Methyl quinoline
1055	
1103	Dimethyl quinoline (3 isomers)
1126	
1169	
1192	
1195	C_3 Quinoline* (6 isomers)
1198	
1204	
1239	
1264	C_4 Quinoline*
1314	9H-Carbazole
1329	2-Methyl naphthylisocyanide
1380	9-Methyl-9H-carbazole
1399	N-(phenylmethyl)-benzenemethanamine
1439	[1,1'-Biphenyl]-2-carboxamide
1457	Anthracene/phenanthrene
1466	Acridine
1476	Benzo[h]quinoline
1497	9H-Fluoren-9-imine
1519	Methyl acridine

Qualitative Analysis
Sample 2-2346
Acid Extract

Scan #	Compound
1555 1565 1578 1595	Methyl benzo[f]quinoline (4 isomers)
1617 1626	Phenylindole (2 isomers)
1610 1618 1625 1631 1639 1652 1658 1661 1669 1675 1688 1692	Methyl-phenyl-1H-indole (12 isomers)
1703 1719 1765 1788	Anthracenecarbonitrile (4 isomers)
1809 1821 1856 1881	Methyl anthracenecarbonitrile (4 isomers)

Qualitative Analysis
Sample 2-2346
Acid Extract

Scan #	Compound	
1853 1895 1907	Diphenylpyridene	(3 isomers)
2040 2047	Methyl benz[c]acridene	(2 isomers)
2451	Dibenz[a,j]acridene	

*C_3, C_4 etc - the compound has additional Methyl (CH_3), Ethyl (CH_3, CH_2) etc. Groups attached to total the subscripted number of additional carbon atoms.

Qualitative Analysis

Sample 2-2346

Base Extract

Scan #	Compound	
850	Naphthalene	
992	2-Methyl naphthalene	
1012	1-Methyl naphthalene	
1121		
1137		
1141	C_2 Naphthalene *	(4 isomers)
1159		
1172	Acenaphthylene	
1209	1,2-Dihydroacenaphthylene	
1244	Dibenzofuran	
1244	Naphthalenol	
1311	9H-Fluorene	
1341	Methyl naphthalenol	
1442	Dimethyl-1-naphthol	
1489	Dibenzodioxin	(2 isomers)
1556		
1502	Anthracene/Phenanthrene	
1528	3-Methoxy-1,1'-biphenyl	
1569		
1586	Methyl dibenzothiophene	(4 isomers)
1662		
1674		
1639	Methyl 9H-Pyrido[3,4-b]indol-7-ol	(2 isomers)
1650		

Qualitative Analysis
Sample 2-2346
Base Extract

Scan #	Compound	
1608	Methyl dibenzofuran	(2 isomers)
1628		
1742	Fluoranthene	
1785	Pyrene	
1794	4-Methyl benzo[c]cinnoline	
1804	1-Phenanthrenol	

* C_3,C_4 etc The compound has additional Methyl(CH_3), Ethyl(CH_3CH_2) etc. Groups attached to total the subscripted number of additional carbon atoms.

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound	
362	Ethylbenzene	
374	Xylene	(3 isomers)
411		
524		
533		
573	C_3 Benzene *	(4 isomers)
618		
638	1-Propenyl benzene	
652	1H-Indene	
672		
703		
712	C_4 Benzene *	(5 isomers)
756		
762		
714	1-Ethenyl-3-ethylbenzene	
728	1-Ethenyl-3,5-dimethylbenzene	
741	Methyl benzofuran	
769	1-Methyl-2-(2-propenyl)benzene	
789	2,3-Dihydro-4-methyl-1H-indene	
804		
812	Methyl-1H-indene	(3 isomers)
824		
856	Naphthalene	
863	Benzo[b]thiophene	
866	Methyl decane	

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound	
930	1,2-Dihydro-2-methyl naphthalene	
935	2,3-Dihydro-4,7-dimethyl-1H-indene	
942	1,2-Dihydro-3-methyl naphthalene	
945	1,1-Dimethyl-1H-indene	
956	1,2-Dihydro-6-methyl naphthalene	
997	2-Methyl naphthalene	
1005	6-Methyl benzo[b]thiophene	
1017	1-Methyl naphthalene	
1093	1,1'-Biphenyl	
1110		
1123		
1140	C_2 Naphthalene*	(6 isomers)
1144		
1162		
1179		
1131	Dihydroacenaphthylene	(2 isomers)
1150		
1175	Acenaphthylene	
1208		
1218		
1270	Methyl-1,1'-biphenyl	(5 isomers)
1283		
1259		
1213	Acenaphthene	

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound	
1229	2-(1-Methylethyl)-naphthalene	
1246	Dibenzofuran	
1252		
1258		
1275	C_3 Naphthalene *	(5 isomers)
1278		
1292		
1295	1H-Phenalene	
1316	9H-Fluorene	
1340	1-(2-Propenyl)-naphthalene	
1351		
1364	Methyl dibenzofuran	(3 isomers)
1376		
1386	Dimethyl Biphenyl	
1397	1-Methyl-7-(1-methylethyl)-naphthalene	
1406	9,10-Dihydrophenanthrene	
1427		
1434	Methyl-9H-fluorene	(3 isomers)
1444		
1459	2-Methoxy-9H-fluorene	
1480	Dibenzothiophene	
1510	Anthracene/Phenanthrene	
1545	Dimethyl-9H-fluorene	
1555	9H-Carbazole	

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound	
1571	1-Phenyl naphthalene	
1605		
1611		
1619	Methyl phenanthrene	(5 isomers)
1628		
1632		
1697		
1704	C_2 Phenanthrene *	(3 isomers)
1720		
1747	Fluoranthene	
1790	Pyrene	
1839	Methyl pyrene	(2 isomers)
1860		
1873	11H-Benzo[a]fluorene	
1893	11H-Benzo[b]fluorene	
1947	1,1':2',1"-Terphenyl	
1983	Benzo[b]naphtho[1,2-d]thiophene	
1990	Benzo[c]phenanthrene	
2031	Chrysene	
2039	Benz[a]anthracene	
2054	triphenylene	
2106		
2114	Methyl [chrysene / benz[a]anthracene / triphenylene]	(4 isomers)
2121		
2131		

Qualitative Analysis
Sample 2-2346
Neutral Extract

Scan #	Compound
2239	Benzo[k]fluoranthene
2256	Benzo[j]fluoranthene
2289	Benzo[e]pyrene
2300	Benzo[a]pyrene
2317	Perylene
2577	Indeno[1,2,3,-cd]pyrene
2585	Dibenzanthracene
2651	Benzo(ghi)perylene
3088	Dibenzpyrene

* C_3,C_4 etc The compound has additional Methyl(CH_3), Ethyl(CH_3CH_2) etc. Groups attached to total the subscripted number of additional carbon atoms.

Braun

ADMIN. 1030A (REV. 8/76)

STATE OF MINNESOTA

Office Memorandum

DEPARTMENT HEALTH

TO : Jim Pankanin
U.S. Environmental Protection Agency
Enforcement Division
230 S. Dearborn
Chicago, Illinois 60604

DATE: 5/21/81

FROM :

PHONE: 612-296-5257

SUBJECT: Hickok Report 6-18-3 : Acceptable Contaminant Levels

I am forwarding to you for your information and review a copy of Hickok's report "Acceptable Contaminant Levels". This is a revision of their earlier report.

002614

MEMORANDUM NO. G18-3

DATE: May 19, 1981

TITLE: ST. LOUIS PARK GROUNDWATER CONTAMINATION STUDY LITERATURE REVIEW - ACCEPTABLE CONTAMINANT LEVELS

revised edition

ABSTRACT: ACCEPTABLE CONTAMINANT LEVELS, OR CRITERIA, ARE PROPOSED FOR POLYNUCLEAR AROMATIC HYDROCARBONS (PAH) IN WATER AND SOIL, AS RELATED TO SOIL AND GROUNDWATER CONTAMINATION FROM THE FORMER REPUBLIC CREOSOTE SITE IN ST. LOUIS PARK, MINNESOTA. CRITERIA ARE PROPOSED FOR (1) GROUNDWATER, (2) SOIL, (3) DISCHARGE TO SURFACE WATER, AND (4) DISCHARGE TO SANITARY SEWER, AND ARE BASED ON EPA CRITERIA AND LABORATORY DETECTION LIMITS. CRITERIA ARE PROPOSED FOR INDIVIDUAL PAH COMPOUNDS, INCLUDING BOTH KNOWN CARCINOGENS AND OTHER PAH. AN ANNOTATED BIBLIOGRAPHY IS INCLUDED. THIS MEMORANDUM REPRESENTS COMPLETION OF TASK 1040 OF THE REFERENCED PROJECT.

EUGENE A. HICKOK & ASSOCIATES
HYDROLOGISTS-ENGINEERS-545 INDIAN MOUND, WAYZATA, MINNESOTA 55391

EUGENE A. HICKOK & ASSOCIATES
HYDROLOGISTS-ENGINEERS-545 INDIAN MOUND, WAYZATA, MINNESOTA 55391

LITERATURE REVIEW - ACCEPTABLE CONTAMINANT LEVELS

I. INTRODUCTION

This memorandum proposes acceptable contaminant levels (criteria) for polynuclear aromatic hydrocarbons (PAH) in water and soil. Criteria for PAH are required for a rational approach to cleaning up soil and groundwater contamination from the former Republic Creosote site in St. Louis Park.

Criteria for the following are proposed:

- Groundwater
- Soil
- Discharge to surface water
- Discharge to sanitary sewer

Also included in this memorandum is an annctated bibliography of the literature reviewed.

By way of background, two agencies in recent years have established PAH criteria for waters. The World Health Organization in 1971 specified a maximum permissible concentration in drinking water of 200 ng/l for the sum of six PAH compounds (fluoranthene, benzo(a) pyrene, benzo(b) fluoranthene, benzo(k) fluoranthene, benzo(g,h,i) perylene and indeno (1,2,3-c,d) pyrene). This criterion does not have a firm toxicological basis and has generally come to be regarded as obsolete. The U. S. Environmental Protection Agency (EPA) published ambient water quality criteria for PAH in 1978, with an updated version in October 1980. This will be discussed in the sequel.

The primary concern over PAH contamination stems from the cancer-causing, or carcinogenic, property of a number of PAH compounds. Some 12 PAH compounds are listed as "having substantial evidence of carcinogenicity" in the July 14, 1980 EPA publication, "The Carcinogen Assessment Group's List of Carcinogens." These compounds are shown in Table 1 - Carcinogenic PAH. It should be noted that this list is almost surely incomplete: relatively few of the many PAH compounds have been thoroughly investigated for carcinogenicity.

II. REVIEW OF CRITERIA PUBLISHED BY EPA

It is widely held that there is no threshold level for carcinogens, that is, a level of exposure below which there is no carcinogenic effect. Instead, it is believed that very low exposure does cause cancer, but at a proportionately low rate of incidence.

This concept is embodied in the October 1980 EPA document, "Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons," which states:

TABLE 1 - CARCINOGENIC PAH

Benz(a)anthracene

Benzo(a)pyrene

Benzo(b)fluoranthene

Benzo(j)fluroanthene

Chrysene

Dibenz(a,h)anthracene

Dibenzo(a,e)pyrene

Dibenzo(a,h)pyrene

Dibenzo(a,i)pyrene

7,12-dimethylbenz(a)anthracene

Indeno(1,2,3-c,d)pyrene

3-Methylcholanthrene

SOURCE: U. S. Environmental Protection Agency, "The Carcinogen Assessment Group's List of Carcinogens," July 14, 1980.

> For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through ingestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical.

Although this statement may appear logical taken at face value, there are three serious objections to the specification of a zero criterion.

First, no chemical process is capable of absolute, or 100 percent, efficiency. Thus, treatment of any water contaminated with PAH cannot reasonably be expected to yield water meeting a zero criterion. This is a constraint imposed by natural law. (Incidentally, there are certain literature references to activated carbon adsorption efficiencies of 100 percent for some PAH compounds; however, this is a result of numerical round off of some actual efficiency such as 99.95 percent. The truth of the matter is, the only road to 100 percent efficiency is an infinite succession of additional 9's following 99. percent.)

The second objection to a zero criterion is based on the ubiquity of PAH in the earth's environment. The literature reveals that PAH are detected in raw and finished drinking water sources in the U. S. and elsewhere, German groundwater, Belgian aquifers, Norwegian snow, Russian rivers, urban and rural air in Japan, the U. S. and elsewhere, marine and lake sediments, fresh vegetables, meats and fish, grain products, and, as rare minerals, in certain geologic formations. The major source of PAH in the environment is believed to be fossil fuel combustion, so its widespread occurrence is not surprising in light of the possibilities for atmospheric distribution. However, natural fires surely contribute some background of PAH, as does incomplete combustion of most any organic or biogenic material.

In any case, it appears unlikely that a zero level of PAH exists in any environmental sample from any region of the biosphere, excepting perhaps igneous rock and any rock formed prior to the era of terrestrial life. This bold assertion is made with the knowledge that improved analytical techniques have in recent years yielded lower and lower limits of detection for PAH.

Which points to the third objection: despite the great analytical advances, a zero level of PAH cannot be measured. Just as no chemical process can be 100 percent efficient, no analytical technique can achieve a zero detection limit. Therefore there is no way to monitor a zero criterion.

Perhaps in recognition of the above objections, the October 1980 EPA document modifies the previously quoted statement with the following:

However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6} and 10^{-7}. The corresponding recommended criteria are 28.0 ng/l, 2.8 ng/l and 0.28 ng/l, respectively.

These EPA criteria are based on a study of the specific compound benzo(a)pyrene (BaP). BaP is believed to be the most potent carcinogen of the PAH. Therefore it is conservative, and reasonable, to use BaP as a basis for other PAH criteria. One way to do this is to apply a concentration limit determined for BaP to other individual PAH compounds. Another way is to require the sum of PAH concentrations to meet a limit originally determined for BaP alone. Both procedures are conservative, but the second one is extremely so, and is particularly difficult to work with because the laboratory detection limits for many PAH exceed the stated concentration limits. For this reason, setting limits for individual compounds is preferable.

III. PROPOSED CRITERIA

The criteria proposed here are based on the EPA criteria, as applied to individual PAH compounds. A combination of risk level and detection limits determines the specific limits. Separate criteria are proposed for those PAH known to be carcinogenic, and for all other PAH. Limits for "other PAH" are set due to concern for synergistic effects (for example, certain non-carcinogenic PAH have been shown to enhance the carcinogenicity of certain PAH carcinogens). Criteria for potable water are first proposed.

The Minnesota Department of Health has commonly adopted a risk level of 10^{-5} for single chemical species. However, a risk level of 10^{-6} is more appropriate for individual carcinogenic PAH compounds, since several such compounds can occur together in creosote-contaminated water. The 10^{-6} risk level corresponds to a concentration limit of 2.8 ng/l for carcinogenic PAH. This is the proposed acceptable level for carcinogenic PAH; however, it is proposed to consider the detection limit as the criterion whenever the detection limit exceeds 2.8 ng/l. Detection limits vary from compound to compound, from laboratory to laboratory, from sample to sample, and from time to time.

The Minnesota Department of Health laboratory can at present measure half or more of the 12 known PAH carcinogens. In this laboratory, the likely range of detection limits is 0.5 - 10.0 ng/l for the carcinogenic PAH.

For other PAH, a concentration limit of 28.0 ng/l is proposed. This corresponds to a 10^{-5} risk level for BaP, but it cannot be related to a risk level for these "other PAH" since they are (at least presumably) non-carcinogenic. This is a purely judgmental limit. It is intended to prevent substantial synergism with carcinogenic PAH possibly present at low levels. As with the carcinogenic limit, whenever a detection exceeds 28.0 ng/l it serves to define the acceptable level in that case.

In summary, PAH criteria for potable water are proposed as follows:

Proposed PAH Criteria for Potable Water:

(1) For each PAH compound designated as carcinogenic, the concentration must be less than 2.8 ng/l or the laboratory detection limit for the compound, whichever is greater;

(2) for each PAH compound not designated as carcinogenic, the concentration must be less than 28.0 ng/l or the laboratory detection limit for the compound, whichever is greater.

The potable water criteria form the basis for acceptable levels of PAH in groundwater, soil, discharge to surface water, and discharge to sanitary sewer, as discussed in the following paragraphs.

Groundwater. The proposed criteria for groundwater are identical with those for potable water. Groundwater in the region is generally of excellent quality, and is widely and heavily used for drinking water.

Soil. The proposed criteria for soil are determined by multiplying the potable water criteria (2.8 ng/l and 28.0 ng/l, respectively, for carcinogenic and "other" PAH) by a Sorption Factor, which describes the tendency for a compound to be adsorbed by (i.e., adhere to) soil particles. The Sorption Factor is the ratio of adsorbed to dissolved concentrations of a compound at equilibrium; it is also called the "partition constant." Based on recent studies by J. C. Means et al. (1979, 1980), the Sorption Factor can exceed 30,000 for certain PAH compounds in certain soils, and a minimum value of 500 appears to be reasonable for the Sorption Factor for carcinogenic PAH. It is recommended that this value (500) be adopted unless more detailed information comes to light. This would imply soil PAH limits of 1,400 ng/kg for carcinogenic PAH, and 14,000 ng/kg for "other" PAH. As before, the detection limit would over-ride when it exceeds the stated limit.

The column studies by Professor Pfannkuch at the University of Minnesota currently being done for the Minnesota Department of Health and U.S. Geological Survey may provide useful information in refining the Sorption Factor. Alternatively, where the organic carbon content of soil is known or estimated, Means et al. (1980) have discovered a good relationship between a PAH compound's aqueous solubility, S, and a parameter (K_{OC}) closely akin to the Sorption Factor. The relationship with S is:

$$\log K_{OC} = -0.82 \log S + 4.07$$

and from K_{OC} and percent organic carbon content (% Org-C) of the soil, the Sorption Factor is determined by:

$$\text{Sorption Factor} = \frac{(K_{OC}) \times (\%\ \text{Org-C})}{100}$$

A paper by Yalkowsky and Valvani (1979) gives additional information useful for determining Sorption Factor values.

Discharge to Surface Water. The proposed criteria for discharge to surface water are very strict, due to the possibility of bioconcentration in fish which may be consumed by humans. This will be illustrated by considering discharge to the Mississippi River.

In this case there is a critical population group in the Twin Cities which consumes large amounts of fish taken from the Mississippi River. The daily intake of river fish may be on the order of one pound (0.4356 kg) for members of this group. The ingestion rate of a particular PAH associated with this fish intake can be estimated for a hypothetical concentration of the PAH in the river water by the following formula:

$$\text{PAH Intake} = (0.4536\ \text{kg/day}) \times \text{BF} \times C_w$$

in which C_w = river water concentration of the PAH, and BF = bioconcentration factor (ratio of PAH concentration in organism - in this case, fish - to concentration in water, following period of equilibration).

Various investigators have found bioconcentration factors of 500 (Southworth, 1977; for anthracene with fathead minnows) and 900 (Lu et al., 1977, cited on page B-1 of the EPA October 1980 Criteria document; for BaP with mosquitofish). The evidence is scant, but a value of 700 appears reasonably typical for BF in the above formula. Bioaccumulation factor

The river water concentration, C_w, which results in a daily PAH intake equal to that in drinking water, at its limiting concentration, can now be determined. For a particular carcinogenic PAH in drinking water, consumption of two liters per day at the limiting concentration of 2.8 ng/l implies a daily intake of 5.6 ng. Substituting this in the previously given formula (along with BF = 700),

$$5.6\ \text{ng/day} = (0.4536\ \text{kg/day}) \times 700 \times C_w$$

and solving for C_w yields a river concentration of 0.018 ng/l. (Note 1 l. water has mass 1 kg.) This limit is less than one hundredth that for drinking water.

Allowance could be made for dilution in the case of discharge to the river. The daily low flow of record for the Mississippi River in the metropolitan area appears to have occurred at Lock and Dam Number 1 on September 1, 1976. (Special river studies were carried out cooperatively by the U.S. Geological Survey with local agencies during the drought period in 1976.) The measured streamflow was 219 cubic feet per second.

Gradient control wells in the shallower aquifers in St. Louis Park (i.e., excluding the Prairie du Chien-Jordan and deeper aquifers, from which pumped water is likely to be treated and used as water supply) may produce a total flow on the order of 800 gallons per minute, or 1.8 cubic feet per second.

The resulting dilution factor (219/1.8) is 122, and applying this to the river concentration limit of 0.018 ng/l yields an allowable effluent concentration of 2.2 ng/l. This is roughly equal to the drinking water limit.

To sum up, discharge to the Mississippi River is severely constrained by the possibility of PAH bioconcentration. In fact, under the assumption that a critical population group consumes one pound of Mississippi fish per person daily, the effluent quality would need to be comparable to drinking water.

Note that smaller dilution factors will result for other surface waters in the area. Minnehaha Creek, for example, exhibits zero flow occasionally. This implies a dilution factor of unity. Thus, discharge to the Creek could possibly need to be of much higher quality than drinking water.

The criteria proposed for discharge to surface water therefore depend on characteristics of the receiving water. For discharge to the Mississippi River, it is proposed to adopt the potable water criteria, since these approximate the results of the analysis above. Specific criteria are not proposed at present for other receiving waters.

Discharge to Sanitary Sewer. The criteria for discharge to sanitary sewer are intended to insure that the Metropolitan Wastewater Treatment Plant at Pig's Eye meets the criteria for surface water discharge to the Mississippi River. For this purpose, the potable water criteria are multiplied by a Dilution Factor.

This factor is the ratio of total wastewater flow at Pig's Eye to the total pumpage from gradient control wells discharging to the sewer. The total wastewater flow is on the order of 200 million gallons per day, and total pumpage from the shallower control wells, again, is likely to be about 800 gallons per minute (1.2 million gallons per day).

The resulting Dilution Factor is then approximately 167. This implies concentration limits of 468 ng/l for each carcinogenic PAH, and 4,680 ng/l for other individual PAH compounds. These are representative numbers, based on approximate or preliminary estimates of flow. And again, the detection limit would define the acceptable level for a compound whenever it exceeds the specified limits.

Summary. Table 2 - Proposed Environmental PAH Criteria, summarizes the above discussion. Note once again that the EPA criteria are the primary basis for the proposed criteria. Also, the detection limit in a given case serves as the acceptable level whenever the detection limit exceeds the limit derived from EPA criteria.

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TABLE 2 - PROPOSED ENVIRONMENTAL PAH CRITERIA

GROUNDWATER: (1) For each PAH compound designated as carcinogenic, the concentration must be less than 2.8 ng/l or the laboratory detection limit for the compound, whichever is greater; (2) for each PAH compound not designated as carcinogenic, the concentration must be less than 28.0 ng/l or the detection limit for the compound, whichever is greater.

SOIL: (1) For each PAH compound designated as carcinogenic, the concentration must be less than 2.8 ng/kg multiplied by a Sorption Factor, or the detection limit for the compound, whichever is greater; (2) for each PAH compound not designated as carcinogenic, the concentration must be less than 28.0 ng/kg multiplied by a Sorption Factor, or the detection limit for the compound, whichever is greater. (See text for discussion of Sorption Factor.)

DISCHARGE TO SURFACE WATER: For discharge to the Mississippi River, the proposed criteria are identical with those for groundwater. (See text for discussion.)

DISCHARGE TO SANITARY SEWER: (1) For each PAH compound designated as carcinogenic, the concentration must be less than 2.8 ng/l multiplied by a Dilution Factor, or the detection limit for the compound, whichever is greater; (2) for each PAH compound not designated as carcinogenic, the concentration must be less than 28.0 ng/l multiplied by a Dilution Factor, or the detection limit, whichever is greater. (See text for discussion of Dilution Factor.)

	g.w.	soil	Miss	sanitary
carc. PAH	2.8 ng/l	2.8 ng/kg	2.8 ng/l	2.8 x dilution factor = 468 ng/l
each non carc PAH	28 ng/l	28	28 ng/l	28 x dilution factor = 4680

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IV. BRIEF BIBLIOGRAPHY

The following relate directly to the above discussion of criteria. Other background documents appear in the annotated bibliography comprising the final section of this memorandum.

1. World Health Organization (1971), 3rd Ed. International Standard for Drinking Water, Geneva.

2. U. S. Environmental Protection Agency (July 14, 1980), "The Carcinogen Assessment Group's List of Carcinogens," 25 pp.

3. U. S. Environmental Protection Agency (October 1980), "Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons," Wash., D.C., 199 pp.

4. Means, J. C., J. J. Hassett, S. G. Wood and W. L. Banwart (1979), "Sorption Properties of Energy-Related Pollutants and Sediments," in Jones and Leber, ed., Polynuclear Aromatic Hydrocarbons, Third International Symposium on Chemistry and Biology - Carcinogenesis and Mutagenesis, Ann Arbon Science, Ann Arbor, pp. 327-340.

5. Means, J. C., S. G. Wood, J. J. Hassett and W. L. Banwart (December 1980), "Sorption of Polynuclear Aromatic Hydrocarbons by Sediments and Soils," Environmental Science and Technology, vol. 14, no. 12, pp. 1524-1528.

V. ANNOTATED BIBLIOGRAPHY

The references listed here are organized under the following headings:

A. EPA Documents

B. Levels in Drinking Water

C. Environmental Levels and Sources

D. Sorption

E. Environmental Fate

F. Hazard and Risk

G. Case Studies

H. Measurement

To avoid confusion, the numbering of references is continuous throughout.

A. EPA DOCUMENTS

1. U.S. Environmental Protection Agency (July 14, 1980), "The Carcinogen Assessment Groups' List of Carcinogens".

   Lists "chemical substances for which substantial or strong evidence exists showing that exposure to these chemicals, under certain conditions, causes cancer in humans, or can cause cancer in animal species which in turn, makes them potentially carcinogenic in humans." Information sources were International Agency for Research on Cancer, National Toxicology Program (formerly National Cancer Institute Bioassay Program), Food and Drug Administration, and previous evaluations by EPA's Carcinogen Assessment Group.

2. U.S. EPA (October, 1980), "Ambient Water Quality Criteria for Polynuclear Aromatic Hydrocarbons", Washington D.C.

   Proposes PAH water quality criteria (intended for surface waters) and thoroughly reviews pertinent information. The information review covers PAH levels in drinking water, food and the environment, as well as human health effects and toxicity to aquatic organisms. The proposed criteria, however, are ambiguous. On Page C-180 (under "Summary of Pertinent Data" in the appendix) the document clearly implies that a criterion is given only for <u>benzo(a)pyrene</u> (BaP):

   > "The water quality criterion for BaP is based on the experiment reported by Neal and Rigdon (1967).. ..The result is that the water concentration of BaP should be less than 28 ng/l in order to keep the individual lifetime risk below 10^{-5}. It is recognized that numerous carcinogenic PAH other than BaP are found in water. However, there is probably little need to derive criteria for all such PAH, since efforts to reduce BaP levels to within acceptable limits will result in the reduction of all PAH."

   But on the preceding page (Page C-179, under "Summary and Conclusion Regarding the Carcinogenicity of Polynuclear Aromatic Hydrocarbons (PAH)" in the appendix), the document presents the same numerical criterion as applicable to the sum of <u>carcinogenic PAH:</u>

> "The water quality criterion for carcinogenic PAH compounds is based on the assumption that each compound is as potent as BaP and that the carcinogenic effect of the compounds is proportional to the sum of their concentrations. Based on an oral feeding study of BaP in mice, the concentration of BaP estimated to result in a lifetime risk of 10^{-5} is 28 ng/l. Therefore, with the assumption above, the sum of concentrations of all carcinogenic PAH compounds should be less than 28 ng/l in order to keep the lifetime cancer risk below 10^{-5}."

And finally, on the report's very first page of text (page vi, which is headed "Criteria Document"), the document gives numerically equivalent criteria for, simply, "polynuclear aromatic hydrocarbons" - which seems to mean the sum of all PAH:

> "For the maximum protection of human health from the potential carcinogenic effects due to exposure of polynuclear aromatic hydrocarbons through injestion of contaminated water and contaminated aquatic organisms, the ambient water concentration should be zero based on the non-threshold assumption for this chemical. However, zero level may not be attainable at the present time. Therefore, the levels which may result in incremental increase of cancer risk over the lifetime are estimated at 10^{-5}, 10^{-6}, and 10^{-7}. The corresponding recommended criteria are 28.0 ng/l, 2.8 ng/l, and 0.28 ng/l, respectively.

The EPA document nowhere compares the merits of these three different interpretations.

3. Sorrell, R. K., H. J. Brass and R. Reding (date unknown), "A Review of Occurrences and Treatment of Polynuclear Aromatic Hydrocarbons", U.S. EPA Cincinnati.

   Literature review of PAH contamination of raw, finished and distributed drinking waters. Included are PAH concentrations measured in ground and surface waters in Germany, surface waters in the Soviet Union and England, and in raw and treated drinking water supplies of 24 cities throughout the U.S. "Concentrations of PAH's in drinking water sources range from nanogram to microgram-per-liter quantities", states the report. Effectiveness of treatment processes is also reviewed.

4. U.S. EPA (date unknown), "Listing Background Document - Wood Preserving".

For wood preserving processes that use creosote or pentachlarophenal, this document states: "The Administrator [of EPA] has determined that wastewater from these wood preserving processes and the resulting bottom sediment sludges from wastewater treatment are solid wastes that may pose a substantial present or potential hazard to human health or the environment when improperly treated, stored, disposed of or otherwise managed, and therefore should be subject to appropriate management requirements under Subtitle C of RCRA." The document supports this conclusion with data and responds to comments from the wood preserving industry on an earlier version of the listing.

B. LEVELS IN DRINKING WATER

(Note that references 2 and 3 contain additional information in this category.)

5. Basu, D. K. and J. Saxena (1978), "Polynuclear Aromatic Hydrocarbons in Selected U.S. Drinking Waters and Their Raw Water Sources," Environ. Sci. Technol., Vol. 12, No. 7.

   Detected PAH in ng/l range in all raw and treated waters from 10 eastern U.S. water supplies.

6. Benoit, F. M., G. L. Lebel and D. T. Williams (1979), "Polycyclic Aromatic Hydrocarbon Levels in Eastern Ontario Drinking Waters, 1978," B. Env. Contam. & Tox., Vol. 23, No. 6

   Concentrations of individual, low-molecular-weight PAH ranged from 0.04 - 6.4 ng/l in treated waters and from 0.1 - 34.4 ng/l in raw waters, for five eastern Ontario municipal water supplies.

7. Quaghebeur, D. and E. DeWulf (1978), "Polynuclear Aromatic Hydrocarbons in the Main Belgian Aquifers," Science of the Total Env., Vol. 10, No. 33.

   Low concentrations of PAH were found in the aquifers of the six main geological formations in Belgium, where groundwater accounts for 65 percent of drinking water supply.

C. ENVIRONMENTAL LEVELS AND SOURCES

8. Borneff, J. and H. Kunte (1967), "Carcinogens in Water and Soil. XIX. Effect of Sewage Purification on Polycyclic Aromatic Compounds," translated by H. Tobias from Arch. Hyg. Bakteriol., 151.

Finds that sewage from households and industry, as well as street runoff, contains considerable quantities of PAH. Sewage treatment reduces carcinogenic PAH (primary settling to about half, activated sludge to ambient river water levels).

9. Blumer, M. and W. W. Youngblood (1975), "Polycylic Aromatic Hydrocarbons in Soils and Recent Sediments," Science, Vol. 188.

Finds that soils and recent marine sediments contain a variety of PAH. In a wide range of depositional environments, the series of alkyl homologs of the PAH are highly similar in molecular weight distribution. The evidence suggests that natural fires produce the PAH, and air movement mixes and disperses them prior to deposition.

10. Blumer, M. (1975), "Curtisite, Idrialite and Pendletonite, Polycyclic Aromatic Hydrocarbon Minerals. Their Composition and Origin," Chemical Geology, 16.

Analysis of these "rare polycyclic aromatic hydrocarbon minerals" reveals the composition of pendletonite as nearly pure coronene, while that of the other minerals includes over 100 PAH and related compounds. The origin of these minerals is medium-temperature pyrolysis of organic matter.

11. Blumer, M., W. Blumer and T. Reich (1977), "Polycyclic Aromatic Hydrocarbons in Soils of a Mountain Valley: Correlation with Highway Traffic and Cancer Incidence," Environ. Sci. & Technol., Vol. 11, No. 12.

Soil PAH near a Swiss mountain tower correlated with proximity to a highway. PAH ranged from 300 mg/kg (dry soil) near the highway, to 4-8 mg/kg in the higher surrounding Alps. (Correlation with cancer is indirect.)

12. Davies, I. W., R. M. Harrison, R. Perry, D. Ratnayaka and R. A. Wellings (1976), "Municipal Incinerator as Source of Polynuclear Aromatic Hydrocarbons in Environment," Environ. Sci. & Technol., Vol. 10, No. 5.

Finds that incomplete combustion of municipal refuse in a continuous feed incinerator produced PAH. Ash waste, stack gases and wastewater from the incinerator plant all contained PAH.

13. Dunn, B. P. and J. Fee (1979), "Polycyclic Aromatic Hydrocarbon Carcinogens in Commercial Seafoods," Canadian J. Fisheries & Aquatic Sciences, Vol. 36, No. 12.

Wet weight concentrations of benzo(a)pyrene ranged from 0.8 - 7.9 ug/kg in commercial lobsters, and from below 10 - 36 ug/kg in other shellfish. Vertebrate fish not packed in vegetable oil contained no detectable BaP. For lobsters, creosote contamination during impoundment was implicated as a cause.

14. Faoro, R. B. and J. A. Manning (1981), "Trends in Benzo(a)pyrene, 1966-77," Journ. Air Poll. Control Assoc., Vol. 31, No. 1.

BaP concentrations in urban air have decreased from approximately 4.0 ng/cu m to less than 1.0 ng/cu m between 1966 and 1977 (averages for 26 U.S. cities). The decrease is primarily attributed to decreased use of coal for residential heating; open-burning bans and coke oven emission controls also contributed to the decrease. In 1975, BaP emissions in the U.S. were mainly accounted for by coke ovens (38%), wood burning for heat (25%), coal refuse fires (17%) and residential coal furnaces (9%).

15. Grimmer, G., H. Boehnke and A. Glaser (1977), "Polycyclische Aromatische Kohlenwasserstoffe Im Abgas Von Kraftfahrzeugen" [Polycyclic Aromatic Hydrocarbons in the Automotive Exhaust Gas], Erdoel Kohle Erdgas Petrochem Ver Brennst Chem, Vol. 30, No. 9.

PAH in car exhaust and fuel was investigated. Comparison reveals that most PAH in fuel is destroyed in combustion, while new and different PAH are produced in the same process.

16. Gubergrits, M. Ya. (1978), "Protection of the Environment from Carcinogenic Pollutants in the Thermal Processing of Solid Fuels," Solid Fuel Chem., Vol. 12, No. 5.

This Soviet study finds that thermal processing of solid fuels (shale and coal) produces substantial benzpyrene, mostly concentrated in the tar and tar waters. The initial fuels contain limited amount of BP.

17. Heit, M. (1979), "Concentrations of Benzo(a)Pyrene in the Sediments of Six Western United States Lakes," Water, Air, Soil Pollution, Vol. 11, No. 4.

Lake sediment concentrations of BaP ranged up to 305 ug/kg, found in a Los Angeles reservoir.

18. Hites, R. A., R. E. LaFlamme and J. W. Farrington (1977), "Sedimentary Polycyclic Aromatic Hydrocarbons: The Historical Record", Science, Vol. 189, P. 829.

Investigated PAH in dated sediment cores from Buzzards Bay, Mass. Some low-level background is thought to be from natural sources, but most of the sedimentary PAH appears to have come from fossil fuel combustion.

19. Shabad, L. M. and G. A. Smirnov (1972), "Aircraft Engines as a Source of Carcinogenic Pollution of the Environment [Benzo(a)pyrene Studies]," Atmos. Environ., Vol. 6, No. 3.

Soviet study finds that both piston and turbine aircraft engines produce BaP in exhaust and soot. Rate of BaP release is from 2-10 mg per minute for modern aircraft engines.

20. Williams, R. L. (1979), "Benxo(a)pyrene Emissions from Gasoline and Diesel Automobiles," SAE Preprint No. 790419 for Feb. 26 - Mar. 2 Meeting.

BaP emission averaged 2.7 ug per mile for diesel and gasoline cars without catalytic converters. Catalytic converters reduced BaP emission by over 95% for gas cars, but had no effect for diesel.

D. SORPTION

21. Herbes, S. E. (1977), "Partitioning of Polycyclic Aromatic Hydrocarbons Between Dissolved and Particulate Phases in Natural Waters", Water Research, Vol. 11, No. 6.

Investigates anthracene adsorption in suspensions of autoclaved yeast cells (a form of particulate organic matter). Sorption was over 10 times greater than that observed on mineral surfaces.

22. May, W. E. (1980), "The Solubility Behavior of Polycyclic Aromatic Hydrocarbons in Aqueous Systems", in L. Petrakis and F. T. Weiss, eds., Petroleum in the Marine Environment, American Chem. Soc., Wash. D.C.

Presents aqueous solubilities for 11 PAH and sorption data for four PAH on several artificial and natural media. Partition coefficients (ratios of concentrations adsorbed onto sediment medium to aqueous concentration at equilibrium) ranged from 1.6 - 159 for artificial media, and from 4.5 - 36 for two undescribed "Alaskan sediments."

23. Means, J. C., J. J. Hassett, S. G. Wood and W. L. Banwart (1979), "Sorption Properties of Energy-Related Pollutants and Sediments", in P. W. Jones and P. Leber, eds., Polynuclear Aromatic Hydrocarbons, Ann Arbor Science Publishers, Ann Arbor.

Reports sorption properties for two PAH on three different soil and lake sediment samples. Partition coefficients ranged from 70 - 12,000, and were proportional to organic carbon content of the soil/sediments. The octanol/water partition coefficient was in turn proportional to the partition coefficients normalized to organic carbon content.

24. Means, J. C., S. G. Wood, J. J. Hassett and W. L. Banwart (1980), "Sorption of Polynuclear Aromatic Hydrocarbons by Sediments and Soils", Environ. Sci. & Technol., Vol. 14, No. 12.

Partition coefficients (both unnormalized and normalized to soil/sediment organic carbon content) are reported for four PAH on 14 soils and sediments. Partition coefficients ranged from 70-56,000 but when normalized ranged from 44,000-6,400,000. The normalized coefficients were related to solubility as well as octanol/water partition coefficient.

25. Rogers, R. D., J. C. McFarlane and A. J. Cross (1980), "Adsorption and Desorption of Benzene in Two Soils and Montmorillinite Clay", Environ. Sci. & Technol., Vol. 14, No. 4.

Reports sorption properties of benzene [which is the basic unit of PAH compounds, and could be termed a "mononuclear aromatic hydrocarbon"]. Freundlich constants which essentially represented linear partition coefficients ranged from 1.8 - 31 for two soil and two clay samples. For the soils, partition coefficients normalized to organic carbon content were about 100. [These results conform to findings for PAH compounds that increasing molecular size and complexity are associated with increasing sorption.]

26. Yalkowsky, S. H. and S. C. Valvani (1979), "Solubilities and Partitioning - 2. Relationships Between Aqueous Solubilities, Partition Coefficients, and Molecular Surface Areas of Rigid Aromatic Hydrocarbons", J. Chem. Eng. Data, Vol. 24, No. 2.

This article presents a reliable equation for 31 PAH compounds, relating the octanol-water partition coefficient to "molecular surface area". A table of component surface areas also is given; this allows estimation of the above parameters for any PAH of known structure. [In conjunction with results in Ref. 24, this allows prediction for any known PAH of soil partition coefficient, normalized to organic carbon content.]

E. ENVIRONMENTAL FATE

27. Carlson, R. M., A. R. Oyler, E. H. Gerhart, R. Caple and K. J. Welch (1979), "Implications to the Aquatic Environment of Polynuclear Aromatic Hydrocarbons Liberated from Northern Great Plains Coal", EPA/600/3-79/093.

Reports bioaccumulation factors of 1,000 - 5,000 for several PAH.

28. Cerneglia, C. E. and D. T. Gibson (1977), "Aromatic Hydrocarbons: Degradation by Bacteria and Fungi", American Chem. Soc., Div. Fuel Chem., Preprint Vol 22, No. 3., Wash., D.C.

Reports investigations on microbial degradation of naphthalene. The fungus Cunninghamella elegans and two Pseudomonas bacteria species were found to metabolize naphthalene.

29. Dean-Raymond, D. and R. Bartha (1975), "Biodegradation of Some Polynuclear Aromatic Petroleum Components by Marine Bacteria", NTIS Report AD/A-006 346.

Finds six bacterial strains (isolated from an oil-polluted estuary) able to metabolize naphthalene and some alkyl homalogs. One strain could also metabolize acenaphthylene, biphenyl, fluorene and tetralin.

30. Gardner, W. S., R. F. Lee, K. Tenore and L. Smith (1978), "Degradation of Selected Polycyclic Aromatic Hydrocarbons in Coastal Sediments: Importance of Microbes and Polychaete Worms," *Water, Air and Soil Poll.*, Vol 11.

Finds significant microbial degradation of several PAH in laboratory experiments with fine sand and medium sand sediments. The benthic polychaete, *Capitella capitata*, stimulated degradation. Microbial degradation was more rapid near the sediment surface than at greater depths. In marsh sediment, PAH degradation was minimal. [Evidence here points to aerobic degradation.]

31. Katz, M. and D. A. Lane (1975), "Photomodification of Benzo(a)pyrene Under Simulated Atmospheric Conditions", Amer. Chem. Soc., Div. Environ. Chem., Preprint Vol. 15, No. 1.

Photodecomposition of BaP occurred with half-life of 5.3 hr. in clean air, and 0.10 hr. in air with 2.0 ppm ozone. [These correspond to 99% reductions each 35 hr. and 0.7 hr., respectively.]

32. Lee, R. F., W. S. Gardner, J. W. Anderson, J. W. Blaylock and J. Barwell-Clarke (1978), "Fate of Polycyclic Aromatic Hydrocarbons in Controlled Ecosystem Enclosures", *Environ. Sci. & Technol.* Vol. 12, No. 7.

Studies of ecosystem enclosures suspended in a coastal inlet demonstrated exponential decrease of six PAH, due to several mechanisms. Microbial degradation appeared significant only for naphthalene (with removal rates up to 5% per day). Higher molecular weight PAH are mainly associated with particulates. Sedimentation and photochemical oxidation are the major processes affecting the aqueous concentrations of the higher molecular weight PAH.

33. MacKenzie, M. J. and J. V. Hunter (1979), "Sources and Fates of Aromatic Compounds in Urban Stormwater Runoff", Environ. Sci. & Technol., Vol. 13, No. 2

PAH in urban runoff was found most likely to originate from crankcase oil, based on comparison of hydrocarbon and sulfur fractions.

34. Southworth, G. R. (1977), "Transport and Transformations of Anthracene in Natural Waters: Process Rate Studies", in L. L. Marking and R. A. Kimerle, eds., Aquatic Toxicology (Proceedings of 2nd Annual Symposium), Amer. Soc. for Testing and Materials, Philadelphia.

Investigates removal of anthracene from water by processes of volatilization, adsorption to bed, photolysis, microbial degradation and sedimentation. First-order rate constants were developed for these processes through laboratory studies. For combined processes, estimated half-lives ranged from 1.4 - 21.6 hr. for various flowing water environments. Microbial degradation dominates removal in slow-moving streams, while photolysis and volatilization become more important in shallow, fast clear water. Bioaccumulation factors of roughly 1,000 and 500 were found for the zooplankter *Daphnia* and fathead minnows, respectively.

F. HAZARD AND RISK

35. Dacre, J. C., D. H. Rosenblatt and D. R. Cogley (1980), "Preliminary Pollutant Limit Values for Human Health Effects", Environ. Sci. & Technol., Vol. 14, No. 7.

Presents a method for determining allowable pollutant levels in soil, based on acceptable daily intake by humans. The article suggests analysis of human exposure pathways and use of partition coefficients and other factors as appropriate.

36. Hervin, R. L. and E. A. Emmett (1976), "Health Hazard Evaluation/Toxicity Determination Report 75-194-324, Western Roofing Co., A. J. Shirk Roofing Co., Quality Roofing Co., Kansas City, Missouri", Nat. Inst. Occup. Safety and Health, Cincinnati.

Results of NIOSH medical-environmental evaluation. Workers were exposed to toxic concentrations of particulate PAH during the tear-off a 7-acre roof. Skin photosensitivity attributed to PAH exposure was found in 71% of the roofers, and conjunctivitis similarly in 65%.

37. Lynn, W. R. (1981), "What Scientists Really Mean by 'Acceptable Risk'", U.S. News & World Report, March 30, 1981.

Interesting discussion of risk, with focus on catastrophes such as occurred at Three Mile Island. Lynn makes the point that, "How safe is safe is a value judgement", and he observes that scientists and technologists have often made such judgements "because nobody else is prepared to do it".

38. Markel, H. L. Jr., R. N. Ligo and J. B. Lucas (1977), "Health Hazard Evaluation/Toxicity Determination Report 75-117-372, Koopers Co., Inc., North Little Rock, Arkansas", NIOSH, Cincinnati

Investigation at wood treating operation revealed potentially toxic PAH concentrations in air. Several cases of skin and eye irritations were attributed to creosote exposure.

39. NIOSH (1980), "Health Hazard Evaluation Determination Report HE-79-43-663, Harbison-Walker Refractories, Clearfield, Pennsylvania", Cincinnati.

Investigation of creosote exposure. PAH were detected in "personal air samples" and were recognized as potentially carcinogenic or co-carcinogenic. NIOSH recommends controlling exposure "to the lowest reliable analytical detection level."

40. van Rensburg, J. F. J., A. Hassett, S. Theron and S. G. Wiechers (1981), "The Fate of Organic Micropollutants Through an Integrated Wastewater Treatment/Water Reclamation System," Municipal Wastewater Reuse News (AWWA Research Foundation), No. 42.

Evaluation of an integrated pilot plant's capability to produce water of potable quality. In this South African study, "lower hazard limits" were set at 100 ng/l per compound for several carcinogenic PAH, at 1,000 ng/l for several non-carcinogenic PAH, and at various levels for other pollutants. The "modified lime flotation biological" plant produced effluent with no PAH exceeding the hazard limits, and the effluent quality is said to be superior to water supplies of Port Elizabeth, Cape Town and Pretoria.

G. CASE STUDIES

41. McCann, D.L. (1978), "Ground Water Quality Conditions During the Year 1977 at the S.C.E.

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Visalia Pole Yard, Visalia, California", prepared by LeRoy Crandall and Assoc. for Southern Calif. Edison Co.

Annual report on groundwater conditions in the vicinity of a pole yard where creosote and pentachlorophenol contamination has occurred. Shallow monitoring wells and deeper municipal wells nearby were monitored: concentrations of pentachlorophenol and of "creosote" ranged, respectively, from 1,700 - 44,000,000 ug/l and from 3,000 - 41,000,000 ug/l in shallow, on-site wells; and for municipal wells, penta was detected in 50% of samples, ranging from 0.1 - 0.2 ug/l, and "creosote" was not detected. During the year reported, a subsurface bentonite-cement cutoff wall was completed around the pole yard (approximately 1,700 lineal feet) down into an underlying silt-clay aquitard (approximately 60 feet deep). Pumpout wells were used and in 1977 produced 531,000 gallons from the shallow aquifer (with maximum penta and "creosote" concentrations of 3,100,000 ug/l and 11,000,000 ug/l, respectively) and 5,000,000 gallons from the deeper, confined aquifer (with average penta about 3,500 ug/l and "creosote" concentrations "generally less than" 7,000 ug/l). All contaminated water was discharged to the Visalia Sewerage System.

42. Thompson, G. E. (1978), "Hydrogeological Control and Clean-Up of Soil and Groundwater Contaminants at Northern Wood Preservers, Ltd.," Proceedings of 25th Ontario Indust. Waste Conf., Ontario Ministry of the Environment, Ottawa.

Report on creosote contamination at plant adjacent to Thunder Bay, Lake Superior. Major portion of spilled materials (mainly creosote, also some chromated copper arsenate and pentachlorophenol) has infiltrated into the ground and is moving laterally into the lake. Remedies have included dredging adjacent portions of the lake. Further plans included barrier or pumpout wells, with effluent treatment by ozonation and activated carbon.

H. MEASUREMENT

(The following list, far from complete, is merely suggestive of the literature concerning PAH measurement technique and detection limits.)

43. Acheson, M. A., R. M. Harrison, R. Perry and R. A. Wellings (1976), "Factors Affecting the Extraction and Analysis of Polynuclear Aromatic Hydrocarbons in Water", Water Research, Vol. 10, No. 3

Investigated effects of initial PAH concentration, presence of suspended solids, prolonged sample storage and other factors affecting measurement. Extraction efficiencies ranged from 30-85%.

44. Bishop, D. F. (1980), "Project Summary, GC/MS Methodology for Measuring Priority Organics in Municipal Wastewater Treatment", U.S EPA, Municipal Environmental Research Laboratory, Cincinnati.

Summarizes EPA methods and limitations for measuring priority organics including certain PAH in municipal wastewaters and sludges. Detection limits are generally stated as ranging from less than 1 - 25 ug/l. Quality control limits for percent recovery were plus-or-minus three standard deviations; it was observed that for many compounds these limits ranged from zero to several hundred percent. [Municipal wastewaters and sludges are especially prone to analytical interferences.]

45. Bolger, J. J., of Environmental Research Group, Inc. (December 2, 1980), letter regarding PAH determination in wastewaters, (accompanying letter from O. C. Braids, Geraghty & Miller, Inc., to J. Erdmann, E. A. Hickok and Associates, dated January 27, 1981.)

Discusses PAH detection limits and reports opinions of Dr. Frank Hammer, head of ERG's Organic Chemistry Department. Dr. Hammer notes that the Minnesota Department of Health's procedure for PAH determination differs slightly from U.S. EPA procedures (published December 3, 1979 in the <u>Federal Register</u>) "and may provide better detection limits". Dr. Hammer could not judge the validity of MDH detection limits as low as 10 ng/l without running a series of analyses using the MDH procedure. [Note that the cited EPA procedures give detection limits by HPLC for 16 PAH ranging from 40 - 5,000 ng/l (considering for each compound only the better of the UV or fluorescence detection limits).]

46. Drew, S. R., of Energy Resources Co., Inc. (November 3, 1980), letter regarding PAH determination, (accompanying letter from A. J. Barber, Geraghty & Miller, Inc., to J. Erdmann, E. A. Hickok and Associates, dated November 6, 1980).

Notes non-EPA approved methods for determining PAH down to the 1 - 10 ng/l level by high performance liquid chromatography. Energy Resources Co.'s lab, using gas chromatography - mass spectrometry, would have PAH detection limits in the 10 - 100 ng/l range, depending on the compound.

47. Hilpert, L. R., W. E. May, S. A. Wise, S. N. Chesler and H. S. Hertz (1978), "Interlaboratory Comparison of Determinations of Trace Level Petroleum Hydrocarbons in Marine Sediments," Anal. Chem., Vol. 50, No. 3

This National Bureau of Standards report compares hydrocarbon determinations in marine sediments by eight laboratories. The scatter of results for PAH compounds (four rings and larger) was typically three orders of magnitude. Determinations were in the ug/kg range.

48. Josephson, J. (1981), "Polynuclear Aromatic Hydrocarbons", Environ. Sci. & Technol., Vol. 15, No. 1.

Article highlights the Fifth International Symposium on Polynuclear Aromatic Hydrocarbons. Advances in PAH detection and analysis, allowing sub-part per billion determinations, are repeatedly noted.

49. Kadar, R., K. Nagy and D. Fremstad (1980), "Determination of Polycyclic Aromatic Hydrocarbons in Industrial Waste Water at the ng/ml Level", Talanta, Vol. 27, pp. 227-230.

Describes combination of column, thin-layer and capillary gas chromatography for PAH determination. From reported data, detection limits were evidently 1 ug/l for several PAH. [Note that 1 ng/ml = 1 ug/l.]

50. Keith, L. H., of Radian Corp. (October 21, 1980), letter regarding PAH detection limits, (accompanying letter from O. C. Braids, Geraghty & Miller, Inc., to J. Erdmann, E. A. Hickok and Associates, dated November 26, 1980).

Notes that detection limits for PAH in 2-liter drinking water samples, concentrated by factor of 2,000, may range from 1 - 40 ug/l using GC-MS. Use of selected ion monitoring can lower the range of detection limits to 100 - 4,000 ng/l (i.e., 0.1 - 4 ug/l). Detection limits can be lowered further yet, to 10 - 500 ng/l range, if capillary GC-MS with selected ion monitoring is used under non-routine conditions, and there are no interferences.

51. Ogan, K., E. Katz and W. Slavin (1978), "Concentration and Determination of Trace Amounts of Several Polycyclic Aromatic Hydrocarbons in Aqueous Samples", J. Chromatogr. Sci., Vol 16, No. 11.

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Reports preliminary method of PAH determination in drinking water, using reversed phase liquid chromatography and fluorescence detection. Specific compounds were recovered quantitatively at levels below 10 ng/l.

52. Ogan, K., E. Katz and W. Slavin (1979), "Determination of Polycyclic Aromatic Hydrocarbons in Aqueous Samples by Reversed-Phase Liquid Chromatography," Anal. Chem., Vol. 51, No. 8.

Describes additional work beyond that in Ref. 51. The technique is applied to 16 PAH (of which 15 are on the EPA Priority Pollutant list) in environmental water samples. Several compounds were quantitated at concentrations below 10 ng/l in the original sample.

53. Oyler, A. R., D. L. Bodenner, K. J. Welch, R. J. Liukkonen, R. M. Carlson, H. L. Kopperman and R. Caple (1978), "Determination of Aqueous Chlorination Reaction Products of Polynuclear Aromatic Hydrocarbons by Reversed Phase High Performance Liquid Chromatography - Gas Chromatography", Anal. Chem., Vol. 50, No. 7.

Reports on "a convenient procedure" combining liquid and gas chromatography with a reverse-phase setup. The procedure quantitates PAH in water at the ng/l to ug/l level.

54. Richardson, J. H. and M. E. Ando (1977), "Sub-Part-Per-Trillion Detection of Polycyclic Aromatic Hydrocarbons by Laser Induced Molecular Fluorescence", Anal. Chem., Vol. 49, No. 7.

Reports very low PAH detection limits using laser-induced molecular fluorescence. All PAH fluorescence was found to depend linearly on concentration, in some cases over six orders of magnitude. Reported detection limits for four PAH range from 0.5 - 4.4 ng/l.

55. Robertson, D. J., R. H. Groth, D. G. Gardner and E. G. Glastris (1979), "Interferences from Filters and Solvents in PNA Analysis by High Performance Liquid Chromatography", J. Air Pollut. Control Assoc., Vol. 29, No. 2.

Reports that PAH are present in most readily available filter media and in solvents used to extract the filters in PAH analysis. The interfering PAH can be detected in solvent samples after concentrating by 50 - 100 x or after extracting an unused filter.

56. Snook, M. E., R. F. Severson, H. C. Higman, R. F. Arrendale and O. T. Chortyk (1979), "Methods for Characterization of Complex Mixtures of Polynuclear Aromatic Hydrocarbons," in P. W. Jones and P. Leber, eds., Polynuclear Aromatic Hydrocarbons, Ann Arbor Science Publishers, Ann Arbor.

Reports on a gel filtration chromatographic technique used in combination with HPLC and GC-MS to characterize complex mixtures of PAH in cigarette smoke condensate. The article notes that almost 1,000 different PAH have been identified in cigarette smoke condensate.

Jraun

ADMIN. 1000A

STATE OF MINNESOTA

Office Memorandum

DEPARTMENT Health

TO : Jim Pankanin
U.S.E.P.A. - Region 5
Enforcement Division
230 S. Dearborn ~~[illegible]~~ Street
Chicago, Illinois 60604

DATE: 5/27/81

FROM : Mike Convery

SUBJECT: Fourth Hickok Work Report : Gradient Control Wells.

I am forwarding to you for your information and review a copy of Hickok's report on Gradient Control Wells. Please return your comments to me by June 10, 1981

received 6-1/81

source of plume info.
how about reinjection?

002583

MEMORANDUM NO. G18-4

DATE: MAY 21, 1981

TITLE: ST. LOUIS PARK GROUNDWATER CONTAMINATION STUDY
CONCEPTUAL ANALYSIS AND DESIGN OF GRADIENT
CONTROL WELL SYSTEM

ABSTRACT: THIS MEMORANDUM AND THE ACCOMPANYING REPORT PRESENT A CONCEPTUAL ANALYSIS AND DESIGN OF A GRADIENT CONTROL WELL SYSTEM FOR CONTAINING GROUNDWATER CONTAMINATION FROM THE FORMER REPUBLIC CREOSOTE SITE IN ST. LOUIS PARK, MINNESOTA. EXISTING WATER SUPPLY WELLS CAN BE USED TO CONTROL CONTAMINANTS IN THE PRAIRIE DU CHIEN-JORDAN AQUIFER. DEEPER AQUIFERS ARE NOT BELIEVED TO REQUIRE GRADIENT CONTROL WELLS, HOWEVER MULTI-AQUIFER WELLS PENETRATING THESE AQUIFERS MUST BE SEALED. FOR THE SHALLOWER AQUIFERS, FIVE WELLS PUMPING APPROXIMATELY 800 GALLONS PER MINUTE CAN CONTROL CONTAMINANT MOVEMENT. CONSTRUCTION COSTS FOR THESE WELLS IS ESTIMATED TO BE APPROXIMATELY $75,000 NOT INCLUDING TREATMENT OR OPERATING COSTS. THIS MEMORANDUM AND THE ACCOMPANYING REPORT REPRESENT COMPLETION OF TASKS 2010 AND 2030 OF THE REFERENCED PROJECT.

EUGENE A. HICKOK & ASSOCIATES
HYDROLOGISTS-ENGINEERS-545 INDIAN MOUND, WAYZATA, MINNESOTA 55391

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CONCEPTUAL ANALYSIS AND DESIGN OF GRADIENT CONTROL WELL SYSTEM

This memorandum and the accompanying report present an analysis of gradient control wells to contain groundwater contamination from the former Republic Creosote site in St. Louis Park. The analysis may be refined as further hydrogeologic data, and perhaps a computer model, become available over the next few months.

The accompanying report describes the analytical approach and identifies and evaluates control alternatives for each aquifer. Included is each aquifer from the drift to the Mt. Simon-Hinckley, approximately 1,000 feet deep. This memorandum summarizes the alternatives and gives estimated well construction costs.

Table A - Summary of Gradient Control Alternatives, shows the key results of the analysis. Contaminant movement in the shallower aquifers (Middle Drift, Platteville and St. Peter) can be contained using five wells pumping a total of approximately 800 gallons per minute, or 1.15 million gallons daily. (Last alternative for each aquifer.) The estimated well construction costs for this total approximately $75,000. This total does not include treatment facilities or any operating costs.

For the Prairie du Chien-Jordan aquifer, the analysis considered only existing water supply wells as possible controls. Alternatives for this aquifer therefore do not have associated well construction costs. Contaminant movement in the Prairie du Chien-Jordan aquifer can be contained by increasing the pumpage of several existing wells (alternative 5). These include municipal wells SLP-15 (St. Louis Park) and H-3 (Hopkins), which have been shut down due to high PAH levels.

The total pumpage to control contaminant movement in the Prairie du Chien-Jordan aquifer is shown in Table A as 9.3 million gallons per day. This includes a substantial amount of pumpage (primarily from the pumping "centers" CP-A through CP-D) currently used for municipal water supply, without special treatment, in St. Louis Park, Hopkins and Edina. Out of the pumpage total (9.3 mgd), at least 2 mgd (for SLP-15 and H-3), and perhaps some greater amount, will require special treatment to reduce PAH levels. The amount which will require special treatment depends on the PAH criteria adopted.

Contamination of the deeper aquifers (Ironton-Galesville and Mt. Simon-Hinckley) is believed to be minor. Multi-aquifer wells reaching these aquifers must be sealed to prevent any further contamination there. Gradient control wells are probably not necessary in the deeper aquifers and have not been designed.

TABLE A - SUMMARY OF GRADIENT CONTROL ALTERNATIVES

Aquifer	Alternative	Gradient Control Wells Designation	Number	@ Rate	Total Pumpage	Resulting Contaminant Movement	Well Construction Cost
Middle drift	1	RW5 & RW6	2	100 gpm	200 gpm	East @ 107 ft/yr	$17,800
	2	RW3 & RW4	2	100 gpm	200 gpm	East @ 104 ft/yr	$17,800
	3	RW1 & RW2	2	100 gpm	200 gpm	Contained	$17,800
Platteville	1	RW1 & RW2*	2	100 gpm	200 gpm	East @ 355 ft/yr	Not estimated
	2	Control via Middle Drift & St. Peter Wells				Contained	0
St. Peter	1	SLP-1,2,3	1	400 gpm	400 gpm	East @ 89 ft/yr	$21,700
	2	RW1 & SLP-1,2,3	2	200 gpm	400 gpm	East @ 83 ft/yr	$38,200
	3	R-1, R-2 & R-3	3	200 gpm	600 gpm	Contained	$57,300
Prairie du Chien-Jordan	1	CP-A, CP-B CP-C & CP-D	4 "Centers"	6 mgd (total)	6 mgd	East @ 45 ft/yr	0**
	2	CP-A, CP-B CP-C & CP-D SLP-15	4 "Centers" 1	6 mgd (total) 1 mgd	7 mgd	Similar to Alt. 1	0
	3	CP-A, CP-B CP-C & CP-D SLP-15, SLP-6 & E-7	4 "Centers" 3	6 mgd (total) 1 mgd	9 mgd	Southeast @ 7 ft/yr	0
	4	CP-A, CP-B CP-C & CP-D SLP-15, SLP-6 H-3	4 "Centers" 2 1	6 mgd (total) 1 mgd 0.5 mgd	8.5 mgd	Northeast @ 14 ft/yr	0

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Aquifer	Alternative	Gradient Control Wells Designation	Number	@ Rate	Total Pumpage	Resulting Contaminant Movement	Well Construction Cost
	5	CP-A, CP-B CP-C & CP-D	4 "Centers"	6 mgd (total)			
		SLP-15 & H-3	2	1 mgd	9.3 mgd	Contained	0
		SLP-6	1	1.3 mgd			
Ironton-Galesville	-	Seal multi-aquifer wells				Unknown, but believed minor	-
Mt. Simon-Hinckley	-	Seal multi-aquifer wells				Believed minor	-

* Note that well designations refer to different wells in different aquifers
** All Prairie du Chien-Jordan alternatives use existing wells only
See accompanying report for locations of designated wells.

To sum up, creosote-waste contaminants in the groundwater near the former Republic Creosote site can be contained by gradient control wells. Total pumpage on the order of 10.5 million gallons per day (including substantial current pumpage for water supply) is required. Existing water supply wells can be used to control the Prairie du Chien-Jordan aquifer. Well construction costs in the shallower aquifers are estimated to be approximately $75,000. Discharge from the shallower control wells (approximately 1.2 million gallons daily) and from some portion of the 9.3 million gallons daily from the Prairie du Chien-Jordan will require special treatment to reduce PAH levels.

$$I = \frac{229.31\ Q}{Tr}$$

$$r = \frac{229.31\ Q}{TI}$$

r = radius (ft)
T = transmissivity
Q = gpm
I = ft/ft

for: ~~the~~ equation
T = 38,600
r = 1,000
find Q

I = 10 ft/mi = .00189

$$Q = \frac{I\,Tr}{229.31} = \frac{(.00189)(38,600)(1,000)}{229.31}$$

= 318 gpm

fig 2 graph

$$T/Q = 130$$

$$Q = \frac{T}{130} = \frac{38,600}{130}$$

= 297 gpm

~~T = K(depth) = 38,600 gpd/ft~~
~~d = 244 ft~~
~~K = T/d = 158 gpd~~
~~7.48 gal/ft³ K = 1.34 ... = 21 ft/d~~

~~q = Km Δh~~
~~= 158 gpd (244 ft)(.00189)~~

~~$V_s = \frac{K\,\Delta h}{n_e} = \frac{158\,(38,600)(.00189)}{(.2)(7.48)}$~~

~~= 98.76 ft/day~~

$T = Kb$ $\qquad$ $1\ gpd/ft^2 = 0.134\ ft/day$

$T = 38600\ gpd/ft$

$b = 244\ ft$ for Prairie du Chien

$$K = \frac{T}{b} = \frac{38600\ gpd/ft}{244\ ft}$$

$= 158\ gpd/\cancel{ft}$

$= 21.17\ ft/day$

$$V = \frac{Ki}{e}$$

$e = .2$

$i = .00189$ $\qquad$ $10\ ft/mi$

$= 1.5\ ft/day$

TASKS 2010 AND 2030
CONCEPTUAL ANALYSIS AND DESIGN OF GRADIENT-CONTROL WELL SYSTEM

Submitted to:

E. A. HICKOK & ASSOCIATES
Wayzata, Minnesota

By:

GERAGHTY & MILLER, INC.
Annapolis, Maryland

April 1981

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FIGURES

TASKS 2010 AND 2030
CONCEPTUAL ANALYSIS AND DESIGN OF GRADIENT-CONTROL WELL SYSTEM

INTRODUCTION

The contaminated ground water in the aquifers underlying St. Louis Park is moving through the earth in directions and at rates determined by natural hydraulic gradients and gradients created by pumping from wells. Hydraulic gradient is the rate of change of pressure head per unit of distance of flow at a given point and in a given direction. According to studies made by the U. S. Geological Survey (USGS), the regional hydraulic gradient within the hydrogeologic system of the St. Louis Park area is generally to the east at about 10 ft/mi. Locally, however, the contaminated ground water in the aquifers may be moving in other directions, due to the influence of pumping from nearby public water-supply wells.

The most practical way of controlling the movement of contaminated ground water is to pump from wells located up-gradient, so that the original gradient in the contaminated body is flattened or reversed. The gradient-control wells must be pumped at the proper rate to achieve the desired level of flattening or reversal at any point within the contaminated ground-water body. The factors that determine the gradient created at any particular point by a pumping well are the (1) rate of pumping, (2) rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient (which is referred to as the transmissivity of the aquifer), and (3) distance from the pumping well to the point. The following formula, based on Darcy's Law, shows the relationship of these factors:

$$I = \frac{229.31\ Q}{Tr} \qquad (1)$$

where,

I = hydraulic gradient in ft/ft,
Q = pumping rate in gpm,
T = transmissivity in gpd/ft, and
r = distance from any point to the pumped well in ft.

Values of transmissivity for the various aquifers in the St. Louis Park area are given in Table 1, which also contains other data on aquifer parameters. These values represent the best information available, but may not be entirely correct for all parts of the study area. Test drilling and test pumping would be needed to improve knowledge in this regard.

Figure 1 is a graphical representation, based on the foregoing formula, of the gradients created by pumping at different radial distances from a gradient-control well. One way of using the graph is to first select a radial distance to the point at which some desired level of gradient

TABLE 1

VALUES OF AQUIFER PARAMETERS

Formations	Depth (ft)	Thickness (ft)	Transmissivity (gpd/ft)	Horizontal Hydraulic Conductivity (gpd/ft²)	Vertical Hydraulic Conductivity (gpd/ft²)	Storage Coefficient	Porosity	Sources of Information (see bibliography)
Upper Drift	65	15-20			0.02 - 2.2			1
Middle Drift	to	20	10,500	20 - 1050			0.3	1
Lower Drift	85	20-30						
Platteville	68-85	20-30	26,000				0.2	*
Glenwood	90-95	2-5			7.5×10^{-5}			1 and 2
St. Peter	93	110	37,500	341	297	1×10^{-4}	0.3	3
Basal St. Peter	203	55			0.015			1 and 2
Prairie du Chien-Jordan	258	244	38,600	158		5×10^{-5}	0.20	2 and 3
St. Lawrence Franconia	502	191	675	3.5	0.035			2
Ironton-Galesville	693	50	112	2.2	1.5		0.25	3
Eau Claire	743	87			5.5×10^{-5}			3
Mt. Simon-Hinckley	830	263	19,500	74	53	8×10^{-3}	0.22	3

* Geraghty & Miller, Inc. estimate

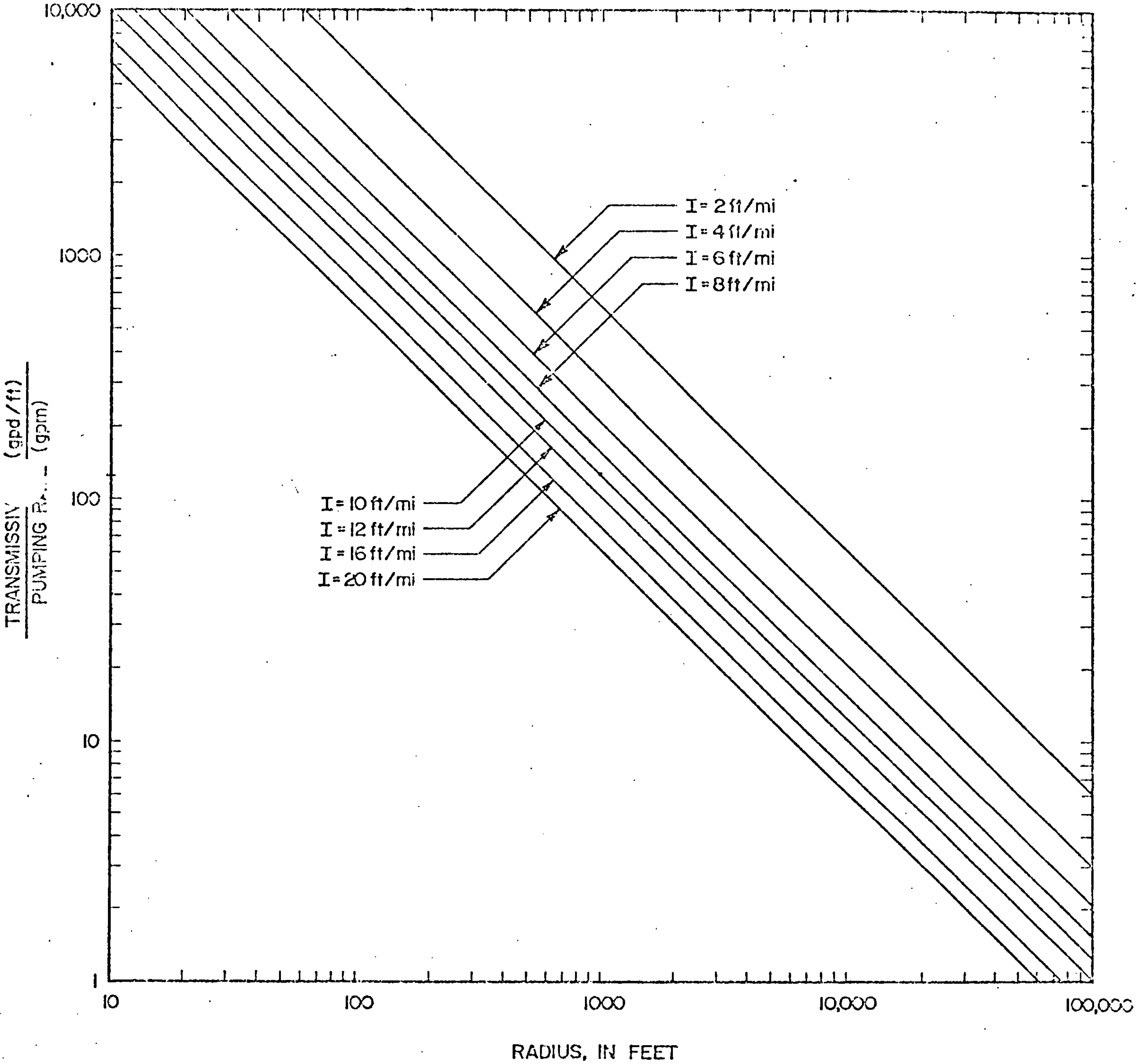

Figure 1. Relationships between gradients, transmissivities, pumping rates and radial distances.

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control is needed and then move vertically upward on the the left and read off the value of transmissivity divided by the pumping rate. Using the proper value of transmissivity from Table 1, the pumping rate for the gradient-control well can then be determined.

An example of how a gradient can be controlled by pumping is given in Figure 2, which shows a hypothetical plume of contamination in any aquifer. If the pre-existing hydraulic gradient at point P-1 is 10 ft/mi to the east, as depicted by the dashed arrow on the illustration, and if the objective is to attain a net hydraulic gradient of zero ft/mi at that point, the solution would be to locate a recovery well at a proper distance to the west. If the aquifer has a transmissivity of 38,600 gpd/ft (which is the reported transmissivity of the Prairie du Chien-Jordan aquifer), calculations using equation 1 or Figure 2 show that a recovery well (RW-1) located 1,000 ft west of point P-1 would have to be pumped at a rate of 319 gpm in order to achieve the net hydraulic gradient of zero ft/mi at point P-1.

IDENTIFICATION AND EVALUATION OF ALTERNATIVES

The present situation at and in the vicinity of the Reilly Company site is that the natural hydraulic gradients

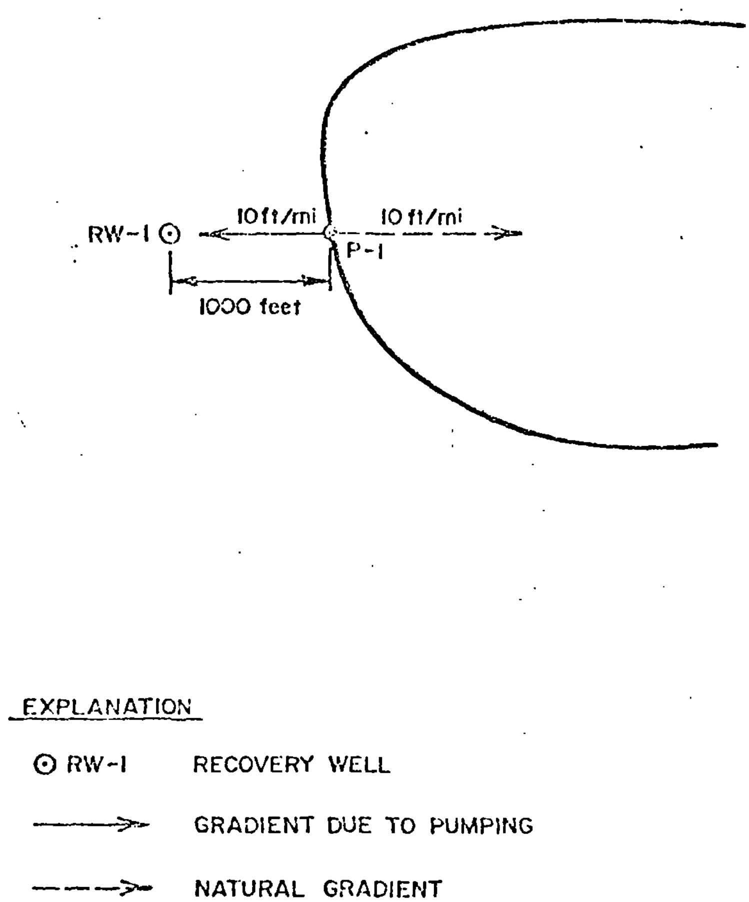


Figure 2. Control of gradient at a point.

are believed to differ from place to place within the contaminated bodies of ground water in all of the aquifers, although no detailed maps of the potentiometric surfaces are available to show these variations. This of course makes it difficult to know how to select sites and pumping rates for an effective gradient-control system. However, several examples of alternative locations and pumping rates were evaluated using the best estimates for aquifer parameters, existing pumping rates for various wells in the area, and an assumed existing hydraulic gradient of 10 ft/mi to the east for all aquifers. The analysis indicated that the most critical points for gradient control lie along the boundary of the plume, with the leading edge of the plume being of greatest concern.

The alternatives included using different numbers and locations of wells to be pumped at different rates within and/or outside the contaminated plumes. Other combinations of recovery wells pumped at different rates and located in other places could be, designed to accomplish the same result. In the following analysis of alternatives, the overlapping effects of pumping from multiple recovery wells were calculated using the basic logic discussed above. Figures 3 through 6 show the boundaries of the plume in the Middle Drift, Platteville, St. Peter, and the Prairie du

Chien-Jordan aquifers, along with desired control points and locations of hypothetical recovery wells. Each of the examples is discussed below.

A. Middle Drift Aquifer

Contaminated ground-water in the Middle Drift aquifer appears to extend approximately 6,000 ft east and approximately 4,000 ft south of the site (see Figure 3) and is estimated to be moving at a rate of 167 ft/yr to the east. The estimated rate of movement was derived in this and all ensuing examples from the equation:

$$V = \frac{K_h I}{\theta}$$

where,

V = rate of movement in ft/yr,
K_h = horizontal hydraulic conductivity in ft/day,
I = hydraulic gradient in ft/ft, and
θ = porosity of the aquifer

Three alternatives were considered in which the recovery wells were pumped at 100 gpm each, using an aquifer transmissivity of 10,500 gpd/ft, to calculate the resultant magnitude and direction of the hydraulic gradients at points P-1 and P-2. The first alternative uses two recovery wells, RW-5 and RW-6, located west of the plume. The calculated

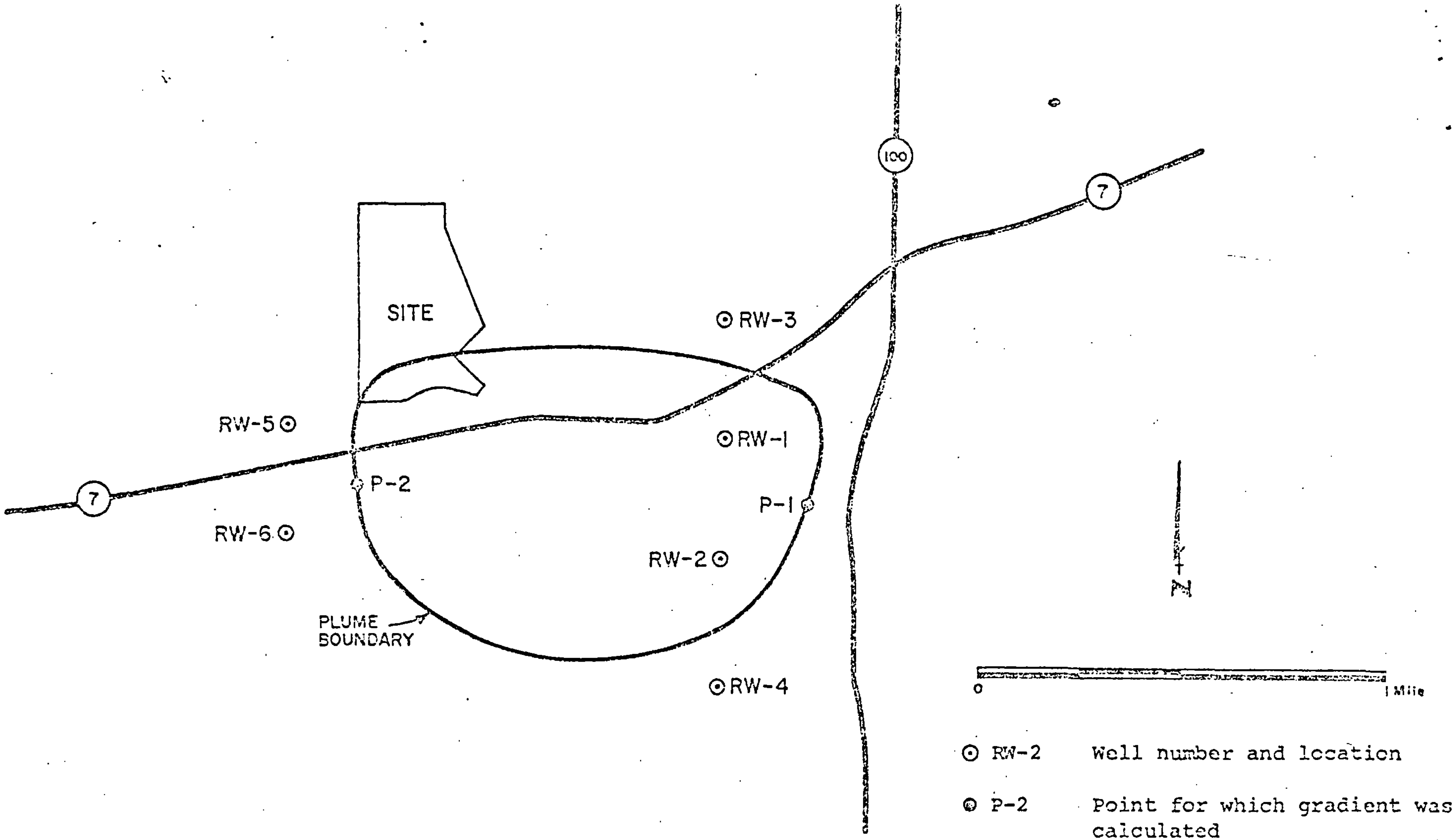


Figure 3. Plume of contamination in the Middle Drift Aquifer showing selected critical points and locations of wells.

resultant hydraulic gradients are 6.6 ft/mi to the east at P-1 and 5.7 ft/mi to the west at P-2. Thus, with this pumping arrangement, the plume would continue to expand to the east and the west. Wells RW-5 and RW-6 would be contaminated in 15 years, and the eastern plume boundary would move to the east at a rate of 107 ft/yr.

The second alternative uses two recovery wells, RW-3 and RW-4, located north and south of the plume. The resultant hydraulic gradients are 6.4 ft/mi to the east at P-1 and 14 ft/mi to the east at P-2. As with the first alternative, contaminated water at P-1 would continue to move to the east at a rate of 104 ft/yr and well RW-3 would be contaminated in about 2 years.

The third alternative uses two recovery wells, RW-1 and RW-2, located within the plume. The resultant hydraulic gradients are 3.1 ft/mi to the west at P-1 and 14.8 ft/mi to the east at P-2. Using this pumping scheme, contaminated water would be pumped from RW-1 and RW-2, but the movement of the contaminated water at P-1 along the eastern edge of the plume would be reversed toward the recovery wells. Movement at all points on the plume boundary would be toward wells RW-1 and RW-2, resulting in a gradual decrease in the size of the contaminated area.

This third alternative would be more effective than the first two in controlling the movement of contaminated ground water.

B. Platteville Aquifer

Contaminated ground water appears to extend about 8,000 ft east and about 4,500 ft south of the site (see Figure 4) and is estimated to be moving at a rate of 483 ft/yr to the east. Two alternatives were considered, the first involving pumping at a rate of 100 gpm from each of the two recovery wells, RW-1 and RW-2, located within the plume. The value of transmissivity used was 26,000 gpd/ft. The resultant net hydraulic gradients are 11.6 ft/mi to the east at P-1 and 7.3 ft/mi to the east at P-2. Thus, contaminated water at P-2 would continue to move to the east at 355 ft/yr.

based on ?

A second alternative would be to allow the Platteville aquifer to continue discharging contaminants into the Middle Drift and St. Peter aquifers, simply because the Platteville cannot be pumped at a high enough rate to stop the movement of contaminants. Under this alternative, the contaminants entering the Middle Drift and St. Peter aquifers, which have a greater thickness and available drawdown than the Platteville aquifer, would be controlled by recovery well systems in those two aquifers. This alternative appears to be a more effective way of dealing with the contamination in the Platteville aquifer.

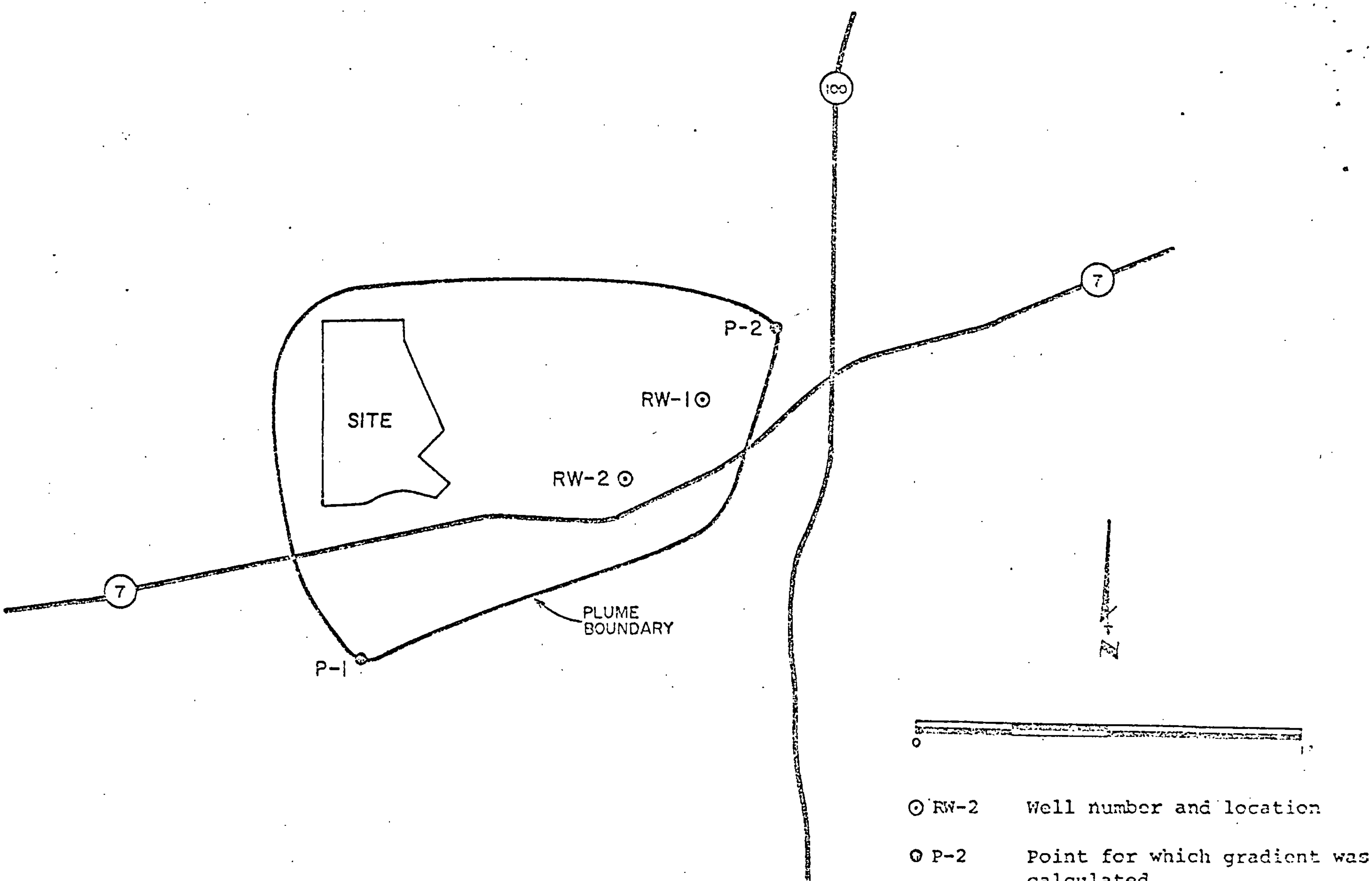
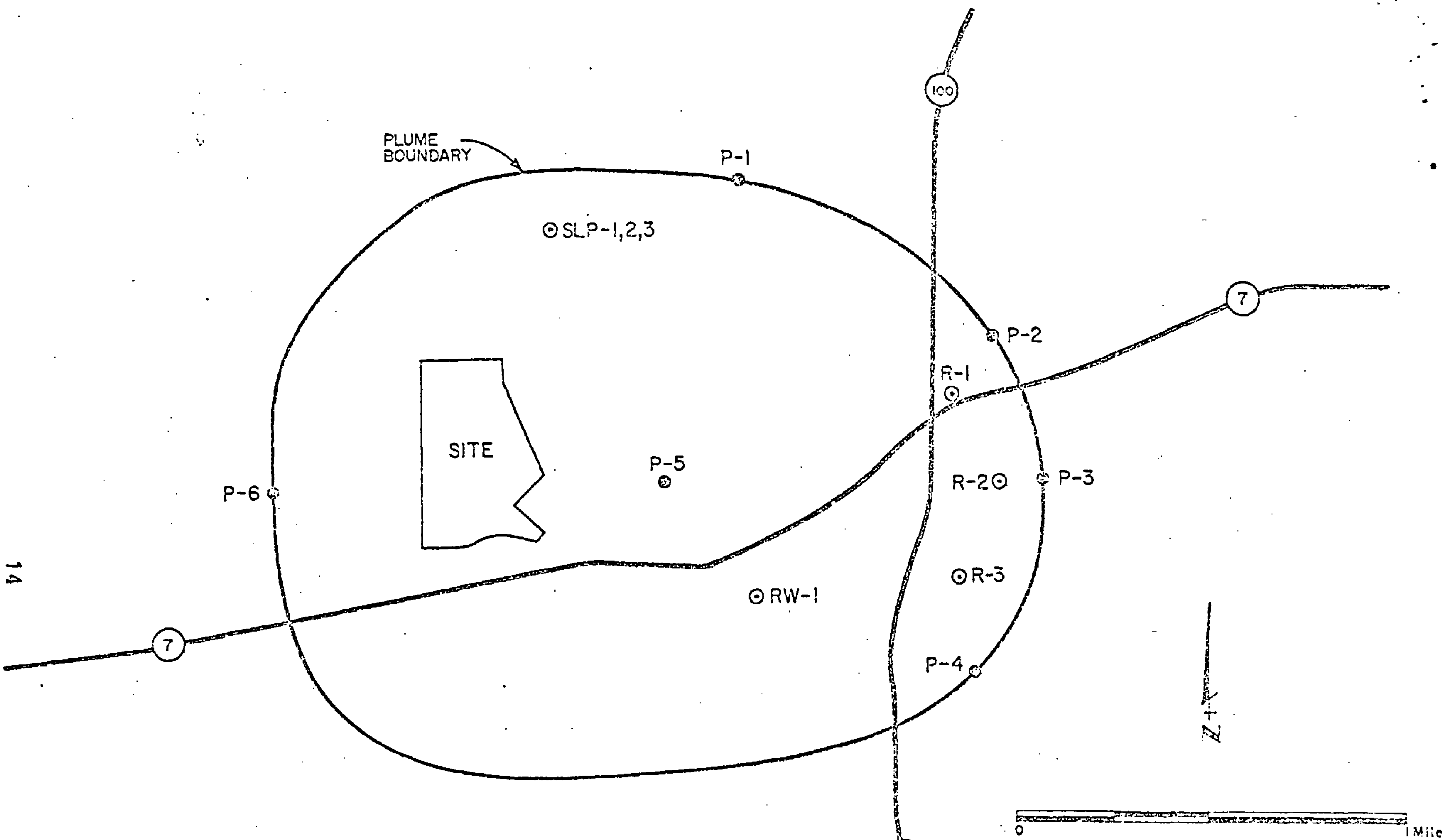


Figure 4. Plume of contamination in the Plattsville Aquifer showing selected critical points and locations of wells.

C. St. Peter Aquifer

Contaminated ground water appears to extend about 7,000 ft east, 2,000 ft west, 2,400 ft north, and 3,000 ft south of the site (see Figure 5) and is estimated to be moving at a rate of 105 ft/yr to the east. Three alternatives were considered, the first involving installation of a new recovery well at the site of existing water-supply wells SLP-1, SLP-2, and SLP-3 (unless one of these wells could be used for this purpose). Using a pumping rate of 400 gpm and an aquifer transmissivity of 37,500 gpd/ft, a net gradient at P-4 of about 8.5 ft/mi toward the east was calculated. Thus, contaminants at P-3 would continue to move to the east at about 89 ft/year.

The second alternative requires the use of two recovery wells at RW-1 and at the site of water-supply wells SLP-1, SLP-2, and SLP-3. Both wells would be pumped at 200 gpm. The resulting net hydraulic gradients would still all be to the east. Specifically, they are 7.9 ft/mi at P-3, 7.6 ft/mi at P-4, 11.5 ft/mi at P-5, and 11.8 ft/mi at P-6. Using this pumping scheme, contaminants at P-3 would continue to move to the east at about 83 ft/yr.



RW-1
R-1 Well number and location
SLP-1,2,3

P-2 Point for which gradient was calculated

Figure 5. Plume of contamination in the St. Peter Aquifer showing selected critical points and location of wells.

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The third alternative requires the use of three recovery wells, R-1, R-2, and R-3, each being pumped at 200 gpm. The resultant net hydraulic gradients, which are all toward the recovery wells, are 12.6 ft/mi at P-1, 12.3 ft/mi at P-2, and 8.4 ft/mi at P-3. This alternative appears to be the most effective means of controlling the contamination in the aquifer.

D. Prairie du Chien-Jordan Aquifer

Contaminated ground water appears to extend about 11,000 ft to the east, 18,800 ft to the south, 4,000 ft to the west, and 2,600 ft to the north of the site (see Figure 6) and is estimated to be moving at a rate of 73 ft/yr to the east. Five alternatives were considered using only existing water-supply wells as recovery wells. For closely spaced water-supply wells pumping at appreciable rates (see Table 2), centers of pumping (CP) were selected so as to reduce the number of calculations in the analysis. For example, CP-A is the center of pumping for water-supply wells SLP-8 and SLP-16. An aquifer transmissivity of 38,700 gpd/ft was used.

The first alternative is to continue pumping the existing wells outside the plume at a combined rate of 6 mgd. Four principal centers of pumping, CP-A through CP-D

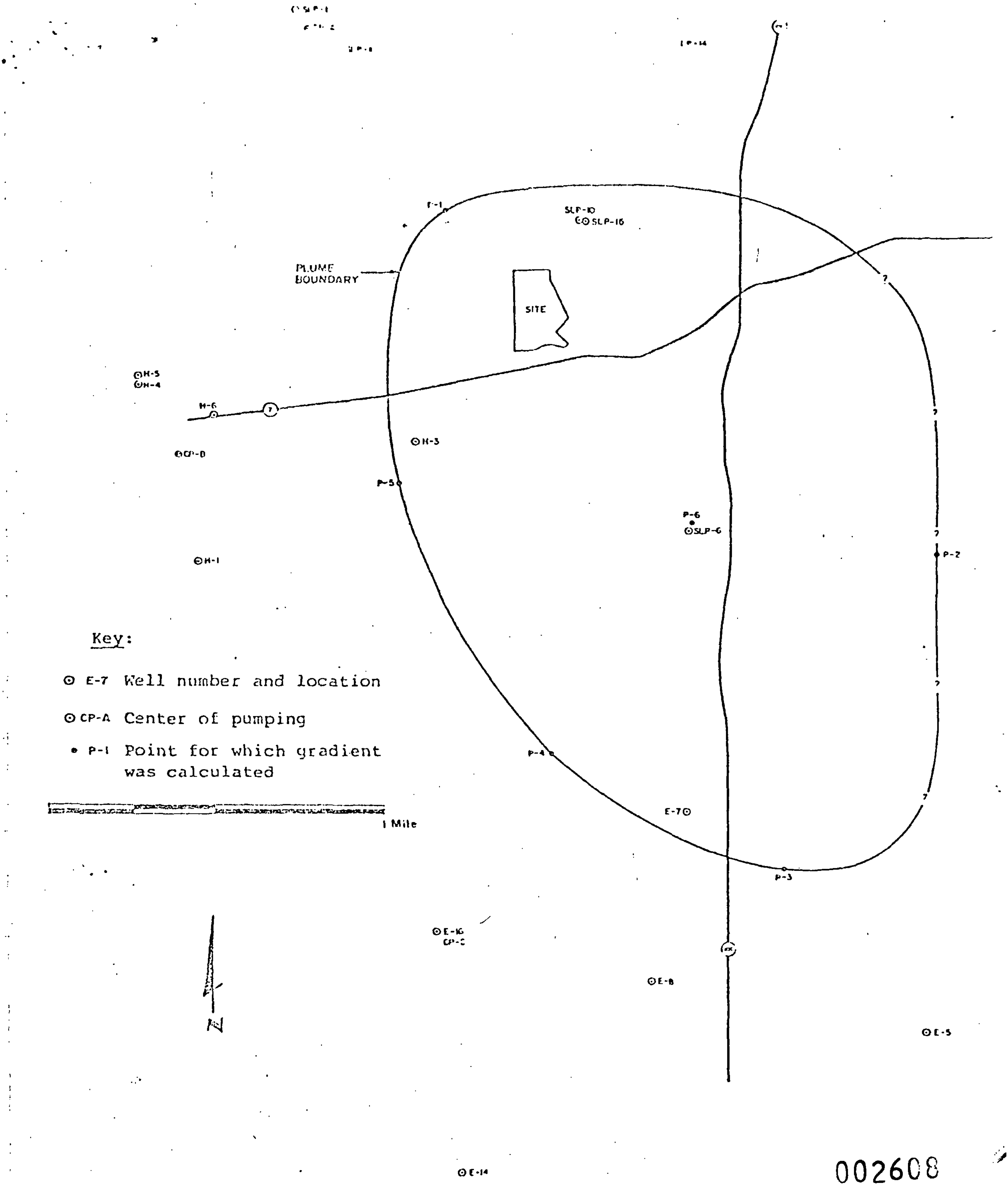

Figure 6. Plume of contamination in the Prairie du Chien-Jordan Aquifer showing selected critical points and locations of wells.

TABLE 2

AVERAGE ANNUAL PUMPING RATE
IN PRAIRIE DU CHIEN-JORDAN
(1979)

St. Louis Park (1979)

Well Number	Pumping Rate, gpm
SLP- 4	221
SLP- 5	39
SLP- 6	859
SLP- 7	0
SLP- 8	721*
SLP- 9	0
SLP-10	0
SLP-14	35
SLP-15	20
SLP-16	739*

* Center of pumping CP-A due to pumping wells SLP-8 and SLP-16

Edina (January through June 1979)

Well Number	Pumping Rate, gpm
E- 2	825
E- 3	4
E- 4	44
E- 5	9*
E- 6	634
E- 7	4
E- 8	2+
E-11	835*
E-13	0
E-14	0+
E-15	42
E-16	253+
E-17	7
E-18	1*

+ Center of pumping CP-C due to pumping wells E-8, E-14 and E-16

* Center of pumping CP-D due to pumping wells E-5, E-11 and E-18

Hopkins (1976)

Well Number	Pumping Rate, gpm
H-1*	512
H-3	136
H-4*	0
H-5*	1092
H-6*	0

* Center of pumping CP-B due to pumping wells H-1, H-4, H-5, and H-6

(see Figure 6), were used in the analysis. The resulting net hydraulic gradients, which are all to the east, are 2.9 ft/mi at P-1, 6.1 ft/mi at P-2, 7.2 ft/mi at P-3, 7.0 ft/mi at P-4, 3.7 ft/mi at P-5, and 5.4 ft/mi at P-6. This pumping scheme would only slow the movement of contaminants to the east, which would still generally be at a rate of about 45 ft/yr at P-2.

The second alternative is to pump the existing centers, CP-A through CP-D, at a total of approximately 6 mgd and to pump existing well SLP-15, located inside the plume, at 1 mgd. The resulting net hydraulic gradients, which are all to the east, range from 5.1 ft/mi to 8.1 ft/mi. This alternative would be hardly better than the first, except that the contaminated ground water within a radius of approximately 2,000 ft from water-supply well SLP-15 would probably move toward that well.

The third alternative is to pump wells SLP-6, SLP-15, and E-7, located inside the plume, at 1 mgd each, in addition to pumping a total of 6 mgd at centers CP-A through CP-D. The resulting net hydraulic gradients are all toward the inside of the contaminated plume, except at P-2 along the eastern boundary, where movement of contaminants would be to the southeast at 7 ft/yr.

The fourth alternative is to pump water-supply wells SLP-6 and SLP-15 at 1 mgd each and water-supply well H-3 at 0.5 mgd, in addition to pumping a total of 6 mgd at centers CP-A through CP-D. The resulting net hydraulic gradients at all points except P-2 are toward the inside of the plume. At P-2, along the eastern edge of the plume, the net gradient would be about 2 ft/mi to the northwest. Thus, the contaminants along the eastern boundary of the plume would continue to move, but the rate of movement would be only about 14 ft/yr.

The fifth alternative is to pump water-supply wells SLP-15 and H-3 at 1 mgd each and water-supply well SLP-6 at 1.3 mgd, in addition to pumping at a total of 6 mgd at centers CP-A through CP-D. The resulting net hydraulic gradients at all points are toward those recovery wells inside the plume. Thus, the spread of the contamination would be stopped and the volume of contaminants would gradually be reduced.

E. Ironton-Galesville Aquifer

Contaminated ground water in this aquifer extends approximately 1,000 ft north, 1,500 ft south, and 5,500 ft east of well W-23, which is located at the site. Because the Ironton-Galesville is not widely used for water supply, perhaps the most ~~sensible~~ way of dealing with the contamination would be to seal or reconstruct all uncased multi-aquifer wells connecting this aquifer with other contaminated aquifers. If the contaminants nevertheless continue to spread, Well W-23 could be used as a recovery well or other recovery wells could be installed.

F. Mt. Simon-Hinckley Aquifer

Contaminated ground water in this aquifer appears to extend about 6,000 ft east and about 3,000 ft north and south of the site. The east-west extent of contamination is due primarily to seepage through the two multi-aquifer wells in the area. The north-south extent of contamination appears to be caused by pumping from the City of St. Louis Park wells 11, 12, and 13.

In order to prevent further contamination, multi-aquifer wells completed in the Mt. Simon-Hinckley aquifer should be sealed. Although a reduction in the spread of contaminants might be accomplished by discontinuing the use of the City of St. Louis Park wells 11, 12, and 13, contaminants would continue to move in the direction of and at the rate of the natural ground-water flow. At this time, the data are insufficient to predict the rate and direction of this natural flow.

002612

The time required for contaminated water to seep into the Mt. Simon-Hinckley through the St. Lawrence-Franconia, the Ironton-Galesville, and the Eau Claire from the Prairie du Chien-Jordan was estimated to be about 4,250 years. The vertical hydraulic conductivities and porosities of the formations between the Mt. Simon-Hinckley and the Prairie du Chien-Jordan are shown in Table 1. The vertical hydraulic gradient used in the calculation of time of travel between the Prairie du Chien-Jordan and the Mt. Simon-Hinckley was 2.3 ft/ft.

6/15/82
N.

GCA CORPORATION
Technology Division

213 Burlington Road
Bedford, Massachusetts 01730
Telephone: 617-275-5444
Telex: 92-3339

June 15, 1982

Mike Kosakowski
U. S. Environmental Protection Agency
Office of Hazardous Waste Enforcement
Fairchild Building, 2nd Floor
499 S. Capital, S. W.
Washington, D. C. 20460

Subject: EPA Contract No. 68-01-6316
Task C
(GCA 1-452-124)

Dear Mike:

The enclosed data package contains the analysis results you requested. Specifically, the following data are included.

- PAH Analysis By HPLC - Fluorescence Of Eleven Water Samples From The Mississippi River.
- PAH Analysis By HPLC - Fluorescence Of Fifteen Water Samples From The MWCC (Seven Influent and Eight Effluent)
- PAH Analysis by HPLC - Fluorescence of Four Empty Sample Containers (Field Blanks).

The data tables are identified by the sample location as submitted on the chain of custody records.

If you have any questions, please feel free to call.

Sincerely,

Mike

Mike Rennekamp
Senior Scientist
Laboratory Analysis Department
GCA/Technology Division

cc: K. T. McGregor
G. T. Hunt
S. M. Sandberg

MER/mdp

Analytical Conditions

Column: Altex Ultrasphere ODS, 4.6 x 250 mm.

Mobile Phase: 70% to 75% Acetonitrile over 20 minutes, then
75% to 100% Acetonitrile over 20 minutes
Second component of mobile phase is water.

Flow rate: 1.0 ml/min.

Chart Speed: 0.1 in/min.

Fluorescence Detector: Excitation 280 nm.
Emission 389 nm.

Temperature: Ambient

Injection Volume: 30 µl

Note: Benzo(k) Fluoranthene is not quantitated in some samples as this component was later determined to be adequately resolved for detection under the above conditions and was subsequently added to the list of parameters.

Project 1-452-124c GCA Control No. 18825

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-827 Analysis Date 6/3/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 7	
Acenaphthene	< 11	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 9	
Phenanthrene	< 1	
Fluoranthene	< 17	
Anthracene	< 2	
Triphenylene	< 1	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	3.0	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 6	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18826

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-840 Analysis Date 6/3/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 7	
Acenaphthene	< 11	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	40,320	
Phenanthrene	< 1	
Fluoranthene	< 17	
Anthracene	< 2	
Triphenylene	< 1	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 2	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 6	

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Project 1-452-124c GCA Control No. 18827

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-847 Analysis Date 6/7/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 7	
Acenaphthene	35	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	126	
Phenanthrene	< 1	
Fluoranthene	< 17	
Anthracene	< 2	
Triphenylene	< 1	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of benzo(b)Fluoranthene
Benzo(a)pyrene	< 2	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 6	

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Project 1-452-124c GCA Control No. 18828

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-859 Analysis Date 6/7/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	< 7	
Acenaphthene	< 11	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	670	
Phenanthrene	< 1	
Fluoranthene	< 17	
Anthracene	< 2	
Triphenylene	< 1	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 2	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 6	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18829

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Ford Dam Analysis Date 6/7/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 7	
Acenaphthene	< 11	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 9	
Phenanthrene	< 1	
Fluoranthene	< 17	
Anthracene	< 2	
Triphenylene	< 1	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 2	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 6	

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Technology Division

Project 1-452-124c GCA Control No. 18931

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Field Bank Analysis Date

Sample Matrix

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration Total Nanograms	Remarks
Naphthalene	< 14	
Acenaphthene	< 23	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 18	
Phenanthrene	< 2	
Fluoranthene	3,040	
Anthracene	50	
Triphenylene	< 2	
Pyrene	< 2	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 4	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 4	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 13	

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Project 1-452-124c GCA Control No. 18932

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff-E; Effluent, MWCC Analysis Date 6/7/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	< 7	
Acenaphthene	< 11	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 9	
Phenanthrene	< 1	
Fluoranthene	< 17	
Anthracene	5	
Triphenylene	< 1	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 2	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 6	

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Project 1-452-124c GCA Control No. 18933

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff-W; Effluent, MWCC Analysis Date 6/7/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 137	
Acenaphthene	< 229	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 182	
Phenanthrene	< 13	
Fluoranthene	8,400	
Anthracene	< 38	
Triphenylene	< 20	
Pyrene	< 13	
Chrysene	< 2	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene		
Benzo(b)fluoranthene	< 34	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 38	
Benzo(g,h,i)perylene	< 6	
Dibenzo(a,h)anthracene	< 4	
Indeno(1,2,3-cd)pyrene	< 122	

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Technology Division

Project 1-452-124c GCA Control No. 18934

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Ford Dam; Mississippi River, Mpls. Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	44	
Acenaphthene	< 7	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	2,270	
Phenanthrene	< 23	
Fluoranthene	< 21	
Anthracene	2	
Triphenylene	< 4	
Pyrene	13	
Chrysene	1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 13	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	5	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 3	

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Project 1-452-124c GCA Control No. 18935

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Gray Cloud; Mississippi River, St. Paul Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	≤ 41	
Acenaphthene	< 7	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	< 23	
Fluoranthene	< 21	
Anthracene	< 2	
Triphenylene	< 4	
Pyrene	< 1	
Chrysene	9	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 13	
Benzo(b)fluoranthene	26	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	2	
Indeno(1,2,3-cd)pyrene	< 14	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18936

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Inf; Influent, MWCC Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	1,580	
Acenaphthene	< 142	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	198,000	
Phenanthrene	49,200	
Fluoranthene	< 416	
Anthracene	241	
Triphenylene	210	
Pyrene	< 8	
Chrysene	< 6	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	2,310	
Benzo(b)fluoranthene	< 44	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 6	
Benzo(g,h,i)perylene	< 6	
Dibenzo(a,h)anthracene	381	
Indeno(1,2,3-cd)pyrene	< 56	

GCA CORPORATION
Technology Division
GCA

Project 1-452-124c GCA Control No. 18937

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-827; Mississippi River, St. Paul Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	< 41	
Acenaphthene	< 7	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	< 23	
Fluoranthene	< 21	
Anthracene	5	
Triphenylene	69	
Pyrene	6	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	87	
Benzo(b)fluoranthene	16	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	12	
Indeno(1,2,3-cd)pyrene	22	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18938

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-840; Mississippi River, St. Paul Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 41	
Acenaphthene	< 7	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	298	
Fluoranthene	< 21	
Anthracene	2	
Triphenylene	< 4	
Pyrene	4	
Chrysene	3	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 13	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 3	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18939

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-847; Mississippi River, Mpls. Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	50	
Acenaphthene	< 7	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	114	
Fluoranthene	< 21	
Anthracene	2	
Triphenylene	< 4	
Pyrene	2	
Chrysene	2	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 13	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 3	

Project 1-452-124c GCA Control No. 18940

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. UM-859; Mississippi River, Mpls. Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 41	
Acenaphthene	< 7	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	364	
Fluoranthene	< 21	
Anthracene	< 2	
Triphenylene	< 4	
Pyrene	2	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 13	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 3	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18977

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Field Blank Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration Total Nanograms	Remarks
Naphthalene	< 81	
Acenaphthene	< 14	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 111	
Phenanthrene	< 46	
Fluoranthene	< 42	
Anthracene	< 3	
Triphenylene	< 8	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 26	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 2	
Indeno(1,2,3-cd)pyrene	< 6	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18978

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff E; MWCC, Effluent - East Bank Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 41	
Acenaphthene	34	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	< 23	
Fluoranthene	< 21	
Anthracene	< 2	
Triphenylene	< 4	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	36	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	4	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 3	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18979

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff W; MWCC, Effluent-West Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	< 41	
Acenaphthene	13	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	< 23	
Fluoranthene	< 21	
Anthracene	< 2	
Triphenylene	< 4	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	21	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	2	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 3	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18980

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Inf E; MWCC, Influent - East Bank Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	< 5,060	
Acenaphthene	542	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 6,940	
Phenanthrene	< 2,840	
Fluoranthene	102,000	
Anthracene	< 186	
Triphenylene	3,300	
Pyrene	< 53	
Chrysene	< 38	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 1,650	
Benzo(b)fluoranthene	< 25	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 38	
Benzo(g,h,i)perylene	220	
Dibenzo(a,h)anthracene	267	
Indeno(1,2,3-cd)pyrene	< 350	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 18981

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Inf Isco; MWCC, Influent-Isco Sampler Analysis Date 6/9/82

Sample Matrix

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 8,100	
Acenaphthene	< 1,420	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	285,000	
Phenanthrene	< 4,540	
Fluoranthene	< 4,160	
Anthracene	< 300	
Triphenylene	< 800	
Pyrene	< 80	
Chrysene	< 60	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 2,640	
Benzo(b)fluoranthene	< 40	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 60	
Benzo(g,h,i)perylene	300	
Dibenzo(a,h)anthracene	301	
Indeno(1,2,3-cd)pyrene	< 560	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19099

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Field Blank Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration Total Nanograms	Remarks
Naphthalene	159	
Acenaphthene	< 14	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	4,500	
Phenanthrene	< 45	
Fluoranthene	< 42	
Anthracene	18	
Triphenylene	4	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 26	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	3	
Dibenzo(a,h)anthracene	2	
Indeno(1,2,3-cd)pyrene	< 6	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19100

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Inf E; MWCC, East Bank, Influent Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	6,760	
Acenaphthene	< 142	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	1,190	
Phenanthrene	< 454	
Fluoranthene	19,100	
Anthracene	112	
Triphenylene	2,340	
Pyrene	< 8	
Chrysene	< 6	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	3,330	
Benzo(b)fluoranthene	< 4	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 64	
Benzo(g,h,i)perylene	< 6	
Dibenzo(a,h)anthracene	< 16	
Indeno(1,2,3-cd)pyrene	< 56	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19101

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Inf E Isco; MWCC, East Influent, Isco Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 810	
Acenaphthene	606	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	6,530	
Phenanthrene	< 454	
Fluoranthene	< 416	
Anthracene	< 300	
Triphenylene	162	
Pyrene	103	
Chrysene	101	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 264	
Benzo(b)fluoranthene	< 40	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 6	
Benzo(g,h,i)perylene	1,220	
Dibenzo(a,h)anthracene	< 160	
Indeno(1,2,3-cd)pyrene	< 560	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19102

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff E; MWCC, East Bank, Effluent Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 41	
Acenaphthene	298	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	90	
Phenanthrene	252	
Fluoranthene	< 21	
Anthracene	< 2	
Triphenylene	< 4	
Pyrene	< 1	
Chrysene	2	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	28	
Benzo(b)fluoranthene	5	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	2	
Dibenzo(a,h)anthracene	1	
Indeno(1,2,3-cd)pyrene	< 3	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19103

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff W; MWCC, West Bank, Effluent Analysis Date 6/9/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	< 41	
Acenaphthene	146	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 56	
Phenanthrene	< 23	
Fluoranthene	< 21	
Anthracene	< 2	
Triphenylene	< 4	
Pyrene	< 1	
Chrysene	< 1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	35	
Benzo(b)fluoranthene	6	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	3	
Dibenzo(a,h)anthracene	< 1	
Indeno(1,2,3-cd)pyrene	< 3	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19157

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Field Blank Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration Total Nanograms	Remarks
Naphthalene	< 81	
Acenaphthene	186	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 111	
Phenanthrene	< 45	
Fluoranthene	< 42	
Anthracene	< 3	
Triphenylene	< 8	
Pyrene	< 1	
Chrysene	1	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 26	
Benzo(b)fluoranthene	< 1	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 1	
Benzo(g,h,i)perylene	< 1	
Dibenzo(a,h)anthracene	< 2	
Indeno(1,2,3-cd)pyrene	< 6	

GCA
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Technology Division

Project 1-452-124c GCA Control No. 19158

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff E II°; MWCC, Effluent East, Auto Samples Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 405	
Acenaphthene	106	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	< 555	
Phenanthrene	< 227	
Fluoranthene	< 208	
Anthracene	< 15	
Triphenylene	< 40	
Pyrene	< 4	
Chrysene	< 3	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 132	
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 3	
Benzo(g,h,i)perylene	< 3	
Dibenzo(a,h)anthracene	< 8	
Indeno(1,2,3-cd)pyrene	< 28	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19159

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Eff W II^{O}: MWCC, Effluent West, Auto Sampler Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 405	
Acenaphthene	< 71	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	2,940	
Phenanthrene	< 227	
Fluoranthene	< 208	
Anthracene	29	
Triphenylene	< 40	
Pyrene	9	
Chrysene	4	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	20	
Benzo(b)fluoranthene	< 2	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 3	
Benzo(g,h,i)perylene	< 3	
Dibenzo(a,h)anthracene	< 8	
Indeno(1,2,3-cd)pyrene	< 28	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19160

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Inf E I^{o}; MWCC, Influent East, Auto-Sampler Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	1,670	
Acenaphthene	< 142	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	197,000	
Phenanthrene	52,200	
Fluoranthene	< 416	
Anthracene	218	
Triphenylene	< 80	
Pyrene	< 8	
Chrysene	554	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	< 264	
Benzo(b)fluoranthene	92	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 60	
Benzo(g,h,i)perylene	125	
Dibenzo(a,h)anthracene	< 160	
Indeno(1,2,3-cd)pyrene	< 560	

GCA CORPORATION
Technology Division

Project 1-452-124c GCA Control No. 19161

DATA REPORT SHEET

Polynuclear Aromatic Hydrocarbons

Sample I.D. Inf I°E Isco; MWCC, East Influent, Isco Analysis Date 6/10/82

Sample Matrix Water

Analytical Method EPA 610 (Federal Register, 40 CFR Part 136, December 3, 1979)

Instrument Dupont 850 HPLC, PE 650-10S Fluorescence/PE LC-75 UV Detectors

Parameter	Concentration (ng/1)	Remarks
Naphthalene	2,390	
Acenaphthene	< 142	Coelutes with acenaphthylene; value calculated on basis of acenaphthene
Fluorene	5,700	
Phenanthrene	52,200	
Fluoranthene	< 416	
Anthracene	917	
Triphenylene	< 80	
Pyrene	< 8	
Chrysene	125	Coelutes with Benzo(a)Anthracene; Value calculated on basis of Chrysene
Benzo(k)fluoranthene	2,100	
Benzo(b)fluoranthene	364	Coelutes with Benzo(e)Pyrene; Value calculated on basis of Benzo(b)Fluoranthene
Benzo(a)pyrene	< 60	
Benzo(g,h,i)perylene	334	
Dibenzo(a,h)anthracene	< 160	
Indeno(1,2,3-cd)pyrene	< 560	

GCA CORPORATION
Technology Division

SF-00006-02

STATE OF MINNESOTA

Office Memorandum

DEPARTMENT POLLUTION CONTROL AGENCY

TO : Steve Shakman, Special Assistant Attorney General
Paul Bitter, U.S. Environmental Protection Agency, Chicago
Mike Convery, Minnesota Department of Health
Marc Hult, United States Geological Survey
Mike Kosakowski, U.S. Environmental Protection Agency, Washington
Bob Leininger, U.S. Environmental Protection Agency, Chicago

DATE: June 24, 1982

FROM : Michael J. Hansel, Regulatory Compliance Section MJH
Solid and Hazardous Waste Division

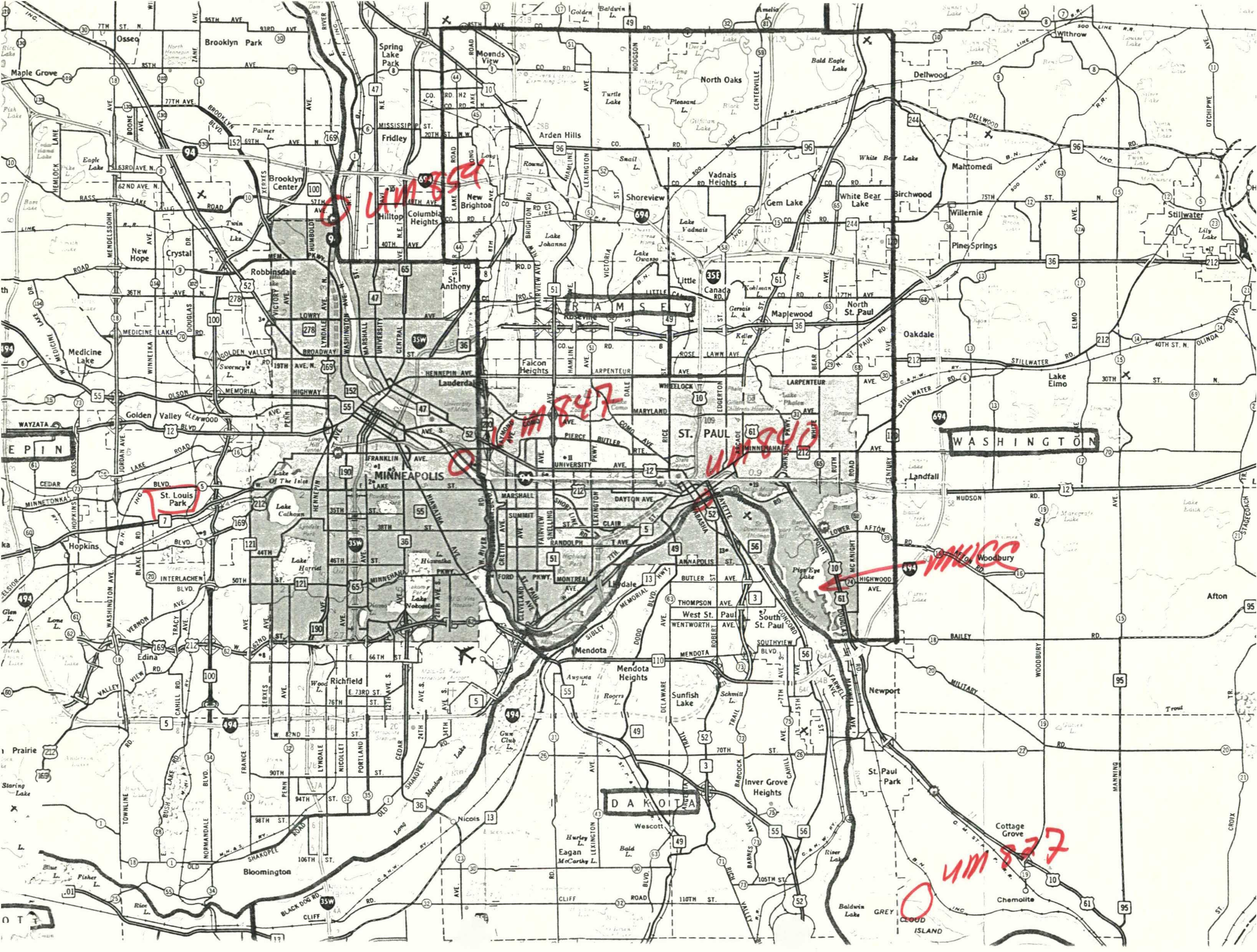
PHONE:

SUBJECT: LOCATION OF MISSISSIPPI RIVER AND MINNESOTA WASTE CONTROL COMMISSION PIG'S EYE PLANT SAMPLES

You recently received a copy of the analyses of river and influent/effluent by GCA. Attached is a copy of a memo which locates where those samples were taken. The sample identification number on the tabulation's from GCA correspond to locations on the river or at the plant. You should note that samples were taken at each location on two different dates, but the tabulations from GCA do not show which is which. I have asked GCA to clarify this, and I will forward the clarification to you as soon as received.

MJH/sf

Attachment



UM 854
UM 847
UM 840
MWCC
UM 827
RAMSEY
WASHINGTON
DAKOTA
EPIN
MINNEAPOLIS
ST. PAUL
Brooklyn Park
Osseo
Maple Grove
Spring Lake Park
Mounds View
North Oaks
Dellwood
Withrow
Fridley
Arden Hills
Brooklyn Center
New Brighton
Hilltop
Columbia Heights
Shoreview
Vadnais Heights
White Bear Lake
Birchwood
Mahtomedi
Willernie
Pine Springs
Stillwater
Gem Lake
Little Canada
Robbinsdale
New Hope
Crystal
St. Anthony
Roseville
Maplewood
North St. Paul
Oakdale
Medicine Lake
Golden Valley
Falcon Heights
Lauderdale
Lake Elmo
Landfall
St. Louis Park
Hopkins
Edina
Richfield
Bloomington
Mendota
Mendota Heights
Lilydale
West St. Paul
South St. Paul
Sunfish Lake
Inver Grove Heights
Newport
St. Paul Park
Cottage Grove
Woodbury
Afton
Eagan
Wescott
Nicols
Chemolite
Grey Cloud Island
Prairie

SF-00006-01

STATE OF MINNESOTA

Office Memorandum

DEPARTMENT POLLUTION CONTROL AGENCY

TO : Gordon Meyer, Chief
Regulatory Compliance Section
Division of Solid and Hazardous Waste

DATE: February 24, 1982

FROM : John F. McGuire, P.E., Chief
Monitoring and Analysis Section
Division of Water Quality

PHONE: 6-7242

SUBJECT: PAH SAMPLING FROM THE MISSISSIPPI RIVER AND THE METRO WASTE CONTROL - ST. PAUL PLANT

The Monitoring and Analysis Section has completed the PAH sampling of the Mississippi River and the Metro Waste Control - St. Paul Plant. The attached sampling program will detail the investigation. The PAH analyses will be forwarded to Rick Ferguson as they become available. Please contact Dan Helwig (296-7288) of my staff if you have any questions.

JFM:DDH/drn

Attachment

cc: Rick Ferguson - Regulatory Compliance Section
Loren Voight - Enforcement
David Maschwitz - Monitoring and Analysis Section
Lovell Richie - Senior Executive Officer
Steve Shakman - Special Assistant, Attorney General

STATE OF MINNESOTA

DEPARTMENT POLLUTION CONTROL AGENCY

Office Memorandum

TO : John F. McGuire, P.E., Chief
Monitoring and Analysis Section

DATE: February 22, 1982

THRU: Marvin E. Hora, Head
Ambient and Intensive Monitoring Unit

FROM : Daniel D. Helwig, Biologist DDH
Monitoring and Analysis Section

PHONE: 6-7288

SUBJECT: PAH SAMPLING FROM THE MISSISSIPPI RIVER AND THE METRO WASTE CONTROL - ST. PAUL PLANT

Introduction:

The Solid and Hazardous Waste Division requested assistance to sample Polynuclear Aromatic Hydrocarbons (PAH) at the Metro Waste Control Commission (MWCC) - St. Paul Plant, the Mississippi River, and the Minnehaha Creek in a memo from Dale Wikre to Barry Schade, dated October 29, 1981. Richard Ferguson called a meeting on December 18, 1981. Marv Hora, Dave Maschwitz, and I attended. Sampling locations, sampling procedures, and sample replication were discussed. Rick summarized the results of the meeting and our later conversations in a memo dated January 11, 1982, to Marv Hora. Sampling was initiated on January 13 and finished on January 28. The details of the sampling program are discussed in this memo. The results are not available at this time.

Methods:

Mississippi River Samples

PAH and non-filtrable residue samples were taken from four sites on the Mississippi River on January 13, and again on January 19, 1982. The samples were taken from 1) the Minnespolis Water Works Plant (UM-859), 2) Ford Dam Generating Plant (UM-847), 3) Lambert's Landing (UM-840), and 4) near Grey Cloud Island (UM-827). (See Table 1). UM-859 was taken from a constantly flowing tap, directly off the intake line from the river, within the Softening Building of the Minneapolis Water Works Plant. UM-847 was taken with a sampling arm, from open water, immediately upstream of the bar screens to the Ford Generating Plant. UM-840 was taken with a sampling arm, through approximately 2" of ice, from Lambert's Landing. UM-827 was taken by hand through approximately 8" of ice, next to a barge mooring pier at the Larson Plant of Shieley, Inc., near Grey Cloud Island.

Grab samples were taken at all Mississippi River stations. Pre-washed glass gallon bottles (PAH) and glass liter bottles were filled directly from the river, to the top, with no sample pre-rinsing. A field blank accompanied the sample containers on the January 19 sampling but not on the January 13 sampling. An internal sample split with GCA Lab. was taken at the Ford Dam site on January 13. Internal splits with GCA Lab. and outside splits with the MDH (see Table1) were taken at the Ford Dam and at the Grey Cloud Island site on January 19.

MWCC - St. Paul Plant

Twenty-four hour composite samples of the influent, effluent, and press cake were taken from the St. Paul Plant on January 18-19, January 20-21, January 25-26, and January 27-28 (See Table 1). The water samples were taken from MWCC automatic, flow-proportioning samplers, and from an Isco auto sampler designed for sampling priority pollutants. The press cake was taken from a conveyor belt leading away from the press cake frames.

Influent entering the St. Paul Plant is divided into East and West banks and further divided into 6 and 2 channels, respectively. The PAH samples were taken from the East Bank, Channels 2 and 5. A 50/50 mixture of the influent from MWCC flow-proportioning auto samplers Mag 2 and Mag 5 (see Figure 1) was used to represent the influent to the whole plant. PVC plastic pipe feed the auto samplers on a flow through basis. Although some contribution and/or uptake of PAH compounds from the pipe is recognized; they are assumed to have reached a steady state condition. To verify this assumption, an Isco sampler, designed for priority pollutants, was set up in the channel to sample from nearly the same point as the auto samplers. The Isco samples are not flow proportioned.

The effluent sample was taken from auto samplers "East Effluent" and "West Effluent". These samplers are similar to the influent samplers, providing flow proportioned composite samples. One sample each sampling day and from each bank was taken because of the differing treatment processes on the waste water.

The press cake sample was taken from a conveyor belt leading away from the press cake frames. An equal amount of press cake (by weight) was spooned into the sample jars each hour for 24 hours.

The influent and effluent from the auto samplers were taken from 6:00 A.M. to 6:00 A.M. as were the press cake samples. The influent Isco sample was taken from 11:00 A.M. to 11:00 A.M. No internal splits for GCA Lab were taken due to the analytical needs of MWCC. External splits for MDH were taken from the influent auto samplers, from the effluent auto west bank sampler, and from the press cake on January 20-21 and January 27-28. (See Table 1.) The press cake samples won't be analyzed by MDH until GCA Lab documents a methodology. All samples were picked up at noon, iced, and shipped overnight to GCA Lab. The shipping coolers were sealed with a MPCA tag with the GCA chain of custody lab sheets and sent with the "SSS Chain of Custody" service of Federal Express. All shipping documentation are enclosed.

DDH/drn

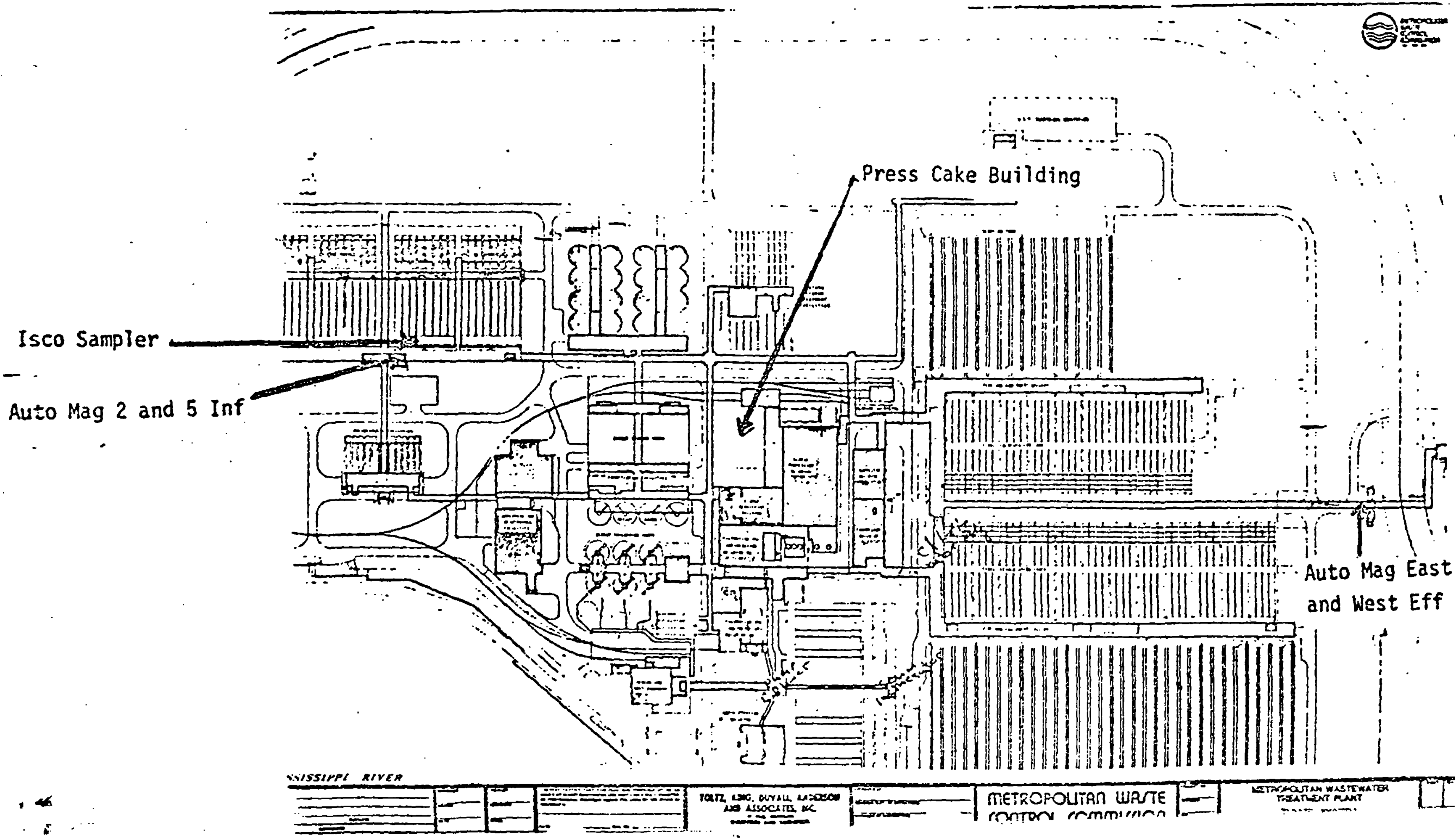
Attachment

TABLE 1. "PAH" SAMPLING DATES, LOCATIONS, AND LABS

Date	Sample Location	Lab GCA PAH	Lab GCA NFR*	Lab MDH PAH
January 13, 1982	Mississippi River (UM-859), Minneapolis Waterworks	1	1	
	Mississippi River (UM-847), Ford Dam	2	1	
	Mississippi River (UM-840), Lambert's Landing	1	1	
	Mississippi River (UM-827), Grey Cloud Island	1	1	
January 19, 1982	Mississippi River (UM-859), Minneapolis Waterworks	1	1	
	Mississippi River (UM-847), Ford Dam	2	1	1
	Mississippi River (UM-840), Lambert's Landing	1	1	
	Mississippi River (UM-827), Grey Cloud Island	2	1	1
	Field Blank	1		1
	Primary Influent East (I°INF E), MWCC	1		
	Secondary Effluent East (II°EFF E), MWCC	1		
	Secondary Effluent West (II°EFF W), MWCC	1		
	Plate and Frame Press Cake, MWCC	1		
January 21, 1982	Primary Influent East (I°INF E), MWCC	1		1
	Primary Influent East (Isco), MWCC	1		
	Secondary Effluent East (II°EFF E), MWCC	1		
	Secondary Effluent West (II°EFF W), MWCC	1		1
	Plate and Frame Press Cake, MWCC	1		1
	Field Blank	1		1
January 26, 1982	Primary Influent East (I°INF E), MWCC	1		
	Primary Influent East (Isco), MWCC	1		
	Secondary Effluent East (II°EFF E), MWCC	1		
	Secondary Effluent West (II°EFF W), MWCC	1		
	Plate and Frame Press Cake, MWCC	1		
	Field Blank	1		
January 28, 1982	Primary Influent East (I°INF E), MWCC	1		1
	Primary Influent East (Isco), MWCC	1		
	Secondary Effluent East (II°EFF E), MWCC	1		
	Secondary Effluent West (II°EFF W), MWCC	1		1
	Plate and Frame Press Cake, MWCC	1		1
	Field Blank	1		1
		34	8	11

* NFR = Nonfilterable Residue

FIGURE 1. MWCC - ST. PAUL PLANT, PAH SAMPLING LOCATIONS



4/20/82
N.

GCA CORPORATION
Technology Division

213 Burlington Road
Bedford, Massachusetts 01730
Telephone 617-275-5444
Telex: 92-3339

April 20, 1982

Mike Kosakowski
U. S. Environmental Protection Agency
Office of Hazardous Waste Enforcement
Fairchild Building, 2nd Floor
499 S. Capitol Street, S. W.
Washington, D.C. 20460

Subject: EPA Contract No. 68-01-6316
TSA 1, WA 24, Task B
(GCA 1-452-124b)

Dear Mike:

Enclosed please find analytical results pertinent to the above task. Results are included for the following water samples:

SLP - 14 (duplicate)
SLP - 15
SLP - 16
SLP - 17

All measurements were collected using HPLC/fluoresence procedures and are reported in ng/l (ppt). Sample preparation procedures were in accordance with EPA Method 610. I've also included a summary listing of instrument operating conditions and laboratory quality control data pertinent to these analyses.

Should you have any questions concerning the enclosed information, please do not hesitate to call me.

Sincerely,

Kenneth T. McGregor
Manager
Laboratory Analysis Department

KTM/mdp

Analysis of Polynuclear Aromatic Hydrocarbons
EPA Method 610

Instrument Conditions

1) Dupont Model 850 High Pressure Liquid Chromatograph.

2) Perkin-Elmer Analytical PAH 0250-0082 column.

3) Perkin-Elmer 650-10S Fluorescence Spectrophotometer; 15 nm slit setting; 280 nm Excitation, 389 nm Emission.

4) Perkin-Elmer LC-75 UV Spectrophotometric detector; 254 nm.

5) Gradient Elution - Linear gradient of 30% Acetonitrile/70% water, increasing to 100% Acetonitrile over 60 minutes; flow rate of 1.0 ml./min.

6) Injection volume - 30 microliters.

Polynuclear Aromatic Hydrocarbon Analysis

Procedural Recovery Control Limits

	Percent Recovery		
	Acenaphthylene	Phenanthrene	Benzo (a) Pyrene
$\bar{X}$ (n=3)	100%	72%	94%
Std. Dev. (S)	28	2	7
2S	56	4	14
Control Limit (± 2S)	44-156%	68-76%	80-108%

Project 1-65 [illegible] GCA Control No. 18131-1

DATA REPORT SHEET
Polynuclear Aromatic Hydrocarbons
EPA Method 610

Sample I.D. SLP 14

Additional Comments Sample SLP 14 (GCA No. 18131-1) and Sample SLP 14 (GCA No. 18131-2) represent replicate analyses

Analyst(s) M. Cardell Checked By R. Robillard

Analysis Date 3/26/82 Report Date 4/13/82

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 37	
Acenaphthene[1]	< 20	
Fluorene	< 200	
Phenanthrene	26	
Fluoranthene	< 250	
Anthracene	< 2	
Triphenylene	< 20	
Pyrene	< 8	
Benzo(a)Anthracene	3	
Chrysene	< 2	
Benzo(e)Pyrene	< 5	
Benzo(b)Fluoranthene	< 40	
Benzo(a)Pyrene[2]	< 1	
Benzo(g,h,i)Perylene	< 10	
Dibenzo(a,h)Anthracene	< 5	
Indeno(1,2,3-cd)Pyrene	< 50	

[1]Coelutes with Acenaphthylene--Value calculated on basis of Acenaphthene.

[2]Coelutes with Benzo(k)Fluoranthene--Value calculated on basis of Benzo(a) Pyrene

Project 1-452-124b GCA Control No. 18131-2

DATA REPORT SHEET
Polynuclear Aromatic Hydrocarbons
EPA Method 610

Sample I.D. SLP 14

Additional Comments Sample SLP 14 (GCA No. 18131-2) and Sample SLP 14 (GCA No. 18131-1) represent replicate analyses.

Analyst(s) M. Gardell Checked By R. Robillard

Analysis Date 3/26/82 Report Date 4/13/82

Parameter	Concentration (rg/l)	Remarks
Naphthalene	< 57	
Acenaphthene[1]	< 20	
Fluorene	< 200	
Phenanthrene	30	
Fluoranthene	< 250	
Anthracene	< 2	
Triphenylene	< 20	
Pyrene	< 8	
Benzo(a)Anthracene	< 3	
Chrysene	< 2	
Benzo(e)Pyrene	< 5	
Benzo(b)Fluoranthene	< 40	
Benzo(a)Pyrene[2]	< 1	
Benzo(g,h,i)Perylene	< 10	
Dibenzo(a,h)Anthracene	< 5	
Indeno(1,2,3-cd)Pyrene	< 50	

[1]Coelutes with Acenaphthylene--Value calculated on basis of Acenaphthene.

[2]Coelutes with Benzo(k)Fluoranthene--Value calculated on basis of Benzo(a) Pyrene

Project 1-452-124b GCA Control No. 18133

DATA REPORT SHEET
Polynuclear Aromatic Hydrocarbons
EPA Method 610

Sample I.D. SLP 16

Additional Comments

Analyst(s) M. Cardell Checked By R. Robillard

Analysis Date 3/26/82 Report Date 4/13/82

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 57	
Acenaphthene[1]	< 20	
Fluorene	< 200	
Phenanthrene	37	
Fluoranthene	< 250	
Anthracene	< 2	
Triphenylene	< 20	
Pyrene	< 8	
Benzo(a)Anthracene	8	
Chrysene	< 2	
Benzo(e)Pyrene	< 5	
Benzo(b)Fluoranthene	< 40	
Benzo(a)Pyrene[2]	< 1	
Benzo(g,h,i)Perylene	< 10	
Dibenzo(a,h)Anthracene	< 5	
Indeno(1,2,3-cd)Pyrene	< 50	

[1]Coelutes with Acenaphthylene--Value calculated on basis of Acenaphthene.

[2]Coelutes with Benzo(k)Fluoranthene--Value calculated on basis of Benzo(a) Pyrene

Project 1-452-124b GCA Control No. 18132

DATA REPORT SHEET
Polynuclear Aromatic Hydrocarbons
EPA Method 610

Sample I.D. SIP 15

Additional Comments

Analyst(s) M. Gardell Checked By R. Robillard

Analysis Date 3/31/82 Report Date 4/13/82

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 57	
Acenaphthene[1]	2,200	
Fluorene	25,000	
Phenanthrene	< 10	
Fluoranthene	20,000	
Anthracene	270	
Triphenylene	86	
Pyrene	< 8	
Benzo(a)Anthracene	17	
Chrysene	< 2	
Benzo(e)Pyrene	< 5	
Benzo(b)Fluoranthene	< 40	
Benzo(a)Pyrene[2]	< 1	
Benzo(g,h,i)Perylene	< 10	
Dibenzo(a,h)Anthracene	< 5	
Indeno(1,2,3-cd)Pyrene	< 50	

[1] Coelutes with Acenaphthylene--Value calculated on basis of Acenaphthene.

[2] Coelutes with Benzo(k)Fluoranthene--Value calculated on basis of Benzo(a) Pyrene

Project 1-[illegible] GCA Control No. 13134

DATA REPORT SHEET
Polynuclear Aromatic Hydrocarbons
EPA Method 610

Sample I.D. SIP 17

Additional Comments

Analyst(s) M. Cardell Checked by R. Robillard

Analysis Date 3/30/82 Report Date 4/[illegible]/82

Parameter	Concentration (ng/l)	Remarks
Naphthalene	< 57	
Acenaphthene[1]	2,100	
Fluorene	4,300	
Phenanthrene	< 10	
Fluoranthene	< 250	
Anthracene	230	
Triphenylene	50	
Pyrene	220	
Benzo(a)Anthracene	10	
Chrysene	< 2	
Benzo(e)Pyrene	< 5	
Benzo(b)Fluoranthene	< 40	
Benzo(a)Pyrene[2]	< 1	
Benzo(g,h,i)Perylene	< 10	
Dibenzo(a,h)Anthracene	< 5	
Indeno(1,2,3-cd)Pyrene	< 50	

[1]Coelutes with Acenaphthylene--Value calculated on basis of Acenaphthene.

[2]Coelutes with Benzo(k)Fluoranthere--Value calculated on basis of Benzo(a) Pyrene

4/16/82
N.

CAPSULE
LABORATORIES

ADVANCED TECHNOLOGY DIVISION
A Division of Economics Laboratory, Inc.
605 West County Road E, St. Paul, MN 55112, (612) 482-8855

Final Report

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS IN MUNICIPAL WATER WELLS FOR THE CITY OF ST. LOUIS PARK

Prepared by:

CAPSULE LABORATORIES
605 West County Road E
Shoreview, Minnesota 55112

Date Submitted:

April 16, 1982

CAPSULE LABORATORIES
ADVANCED TECHNOLOGY DIVISION
A Division of Economics Laboratory, Inc.
605 West County Road E, St. Paul, MN 55112, (612) 482-8855

April 16, 1982

Enclosed is the final report on the analysis of PNA's in municipal well waters of the City of St. Louis Park. Please note that the concentration of Phenanthrene in Well #4B, Capsule #11647, which was previously reported as N.D. has been corrected to read 110 parts-per-trillion. In addition, a table summarizing the present recoveries of deuterated spikes has been included as well as the statement of detection limits for this analysis.

TECHNICAL DATA

Samples Received: 1/15/82
1/27/82

Analysis of Polynuclear aromatics*

Compound	Well #3 Capsule # 11645	Well #4A Capsule # 11646	Well #4B Capsule # 11647	Well #6 Capsule # 11458	Well #8 Capsule # 11648
Naphthalene	N.D. **	N.D.	5	N.D.	N.D.
...phthylene	N.D.	N.D.	N.D.	N.D.	N.D.
Acenaphthene	N.D.	60	92	N.D.	N.D.
Fluorene	N.D.	26	46	N.D.	N.D.
Phenanthrene	N.D.	N.D.	110	N.D.	N.D.
Anthracene	N.D.	7	N.D.	N.D.	N.D.
Fluoranthene	N.D.	N.D.	6	N.D.	N.D.
Pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
Benzo (a) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
...sene	N.D.	N.D.	N.D.	N.D.	N.D.
Benzo (b) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
Benzo (k) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
Benzo (a) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
Indeno (1,2,3-c,d) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
Dibenzo (a,h) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
Benzo (g,h,i) perylene	N.D.	N.D.	N.D.	N.D.	N.D.

*Results expressed as parts-per-trillion (ng/l)

** N.D. = Signal not observed or does not meet criteria for quantitation.

The detection limit for each PNA is 4 ng/l.

TECHNICAL DATA

Samples Received: 1/15/82
1/27/82

Analysis of Polynuclear aromatics*

ompound	Well #11 Capsule # 11459	Well #12 Capsule # 11460	Well #13 Capsule # 11461	Well #14A Capsule # 11462 (spiked)	Well #14B Capsule # 11463
aphthalene	N.D. **	N.D.	N.D.	8	5
ce. thylene	N.D.	N.D.	N.D.	N.D.	N.D.
cenaphthene	N.D.	N.D.	N.D.	N.D.	N.D.
luorene	N.D.	N.D.	N.D.	43	6
henanthrene	N.D.	N.D.	N.D.	N.D.	N.D.
nthracene	N.D.	N.D.	N.D.	28	N.D.
luoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
yrene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (a) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
hr ne	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (b) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (k) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (a) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
ndeno (1,2,3-c,d) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
ibenzo (a,h) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (g,h,i) perylene	N.D.	N.D.	N.D.	N.D.	N.D.

esults expressed as parts-per-trillion (ng/l)

N.D. = Signal not observed or does not meet criteria for quantitation.

e detection limit for each PNA is 4 ng/l.

ECHNICAL DATA

Samples Received: 1/15/82
1/27/82

Analysis of Polynuclear aromatics*

:npound	Well #15A Capsule # 11464	Well #15B Capsule # 11465	Well #16 Capsule # 11649		
.phthalene	4	N.D.**	N.D.		
.enaphthylene	70	N.D.	N.D.		
:en .thene	41	N.D.	N.D.		
.uorene	700	430	N.D.		
ıenanthrene	83	N.D.	N.D.		
ıthracene	160	N.D.	N.D.		
۱uoranthene	380	360	N.D.		
;rene	260	N.D.	N.D.		
:nzo (a) anthracene	14	N.D.	N.D.		
hrysene	14	N.D.	N.D.		
en b) fluoranthene	N.D.	N.D.	N.D.		
enzo (k) fluoranthene	N.D.	N.D.	N.D.		
:nzo (a) pyrene	N.D.	N.D.	N.D.		
ıdeno (1,2,3-c,d) pyrene	N.D.	N.D.	N.D.		
benzo (a,h) anthracene	N.D.	N.D.	N.D.		
:nzo (g,h,i) perylene	N.D.	N.D.	N.D.		

esults expressed as parts-per-trillion (ng/l)

" D. = Signal not observed or does not meet criteria for quantitation.

aetection limit for each PNA is 4 ng/l.

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS

Sampling Equipment

Sampling resin beds used for organic enrichment are connected to a water source by an all-teflon manifold. The teflon manifold is designed to collect samples in duplicate by splitting sample flow with a tee to two resin beds. The inlet of the manifold is compatible with a 1/8" NPT female fitting on the water source. Two teflon needle valves (one on each side of the tee) are used to control water flow through the resin beds. A differential pressure of at least 20 psig is necessary for adequate flow control. When particulate levels are high, a teflon prefilter is placed upstream of the resin beds to remove particulates.

Sampling Procedure

Before sampling, all manifold parts are cleaned with HPLC-grade acetone and ane. Preparation of the resin beds consists of flushing each with 4.0 ml -grade methanol, then 10.0 ml HPLC-grade water. One of the beds is spiked with isotope compounds in the laboratory. The spike level should be similar in concentration to the non-isotopic compounds being analyzed.

At the sampling site, the assembled teflon manifold and resin bed connections are leak-tested. The flow rate through each resin bed is adjusted using the flow valve and the sample flow volume maintained throughout sampling by periodic checks. The water after passing through each resin bed is collected in tared carboys. At the end of the sampling period, the water volume sampled is determined by weighing the carboy and water. At the completion of the sampling, the resin beds are wrapped in foil and kept refrigerated until analysis

Resin Bed Elution

Each resin bed used to collect and concentrate polynuclear aromatic compounds eluted using acidified tetrahydrofuran (THF). The acidified THF is then ses through a micro-drying column to remove water. The dryed THF extract is collected in a 0.1 ml graduated vial. The micro-drying column is rinsed several times with acidified THF. The volume of acidified THF is reduced under a gentle stream of nitrogen at room temperature. Finally, the concentrated extract is spiked with an isotope internal standard (D_{10} anthracene).

GC/MS Analysis

The extracts are stored in suitable vials until ready for analysis. A 1 μl aliquot is injected on the column in a splitless injection mode. Single ion monitoring data is continuously acquired and the data stored for later workup. Instrumental parameters are described in Table I.

Data Reduction - Quantitation

The single ion chromatograms are plotted for the characteristic ion of each plynuclear aromatic being analyzed. Areas are then obtained for any peak with a retention time falling within a one minute window relative to the

standard run. Confirmation of identity is based on presence of the EPA selected ions (see Table II) for the individual compound, and all ions must maximize within one scan of each other. Futhermore, the ions must meet spectral integrity criteria for relative ratios (±20%). The areas under each characteristic ion are used to determine the extract concentration. The areas are compared to the internal standard intensity based on the following formula.

$$\text{Concentration}_{unk} = \frac{(\text{Area}_{unk}) \quad (\text{Conc}_{IS})}{(\text{Area}_{IS}) \ (\text{R.F.}_{unk}) \ (\text{Dilution})}$$

where: unk = priority pollutant being quantitated
IS = internal standard D_{10} anthracene
R.F.= response factor for the particular compound

Recovery Determinations

ı sample to be extracted is spiked with a surrogate standard (a deuterated analog). These materials are carried through the work-up procedure and quantitated along with the normal pollutants. The intensity of these spikes when compared to the area for D_{10} anthracene added to the final extract allows a percent recovery to be determined for each extraction.

$$\text{Percent Recovery} = \frac{\text{Concentration of Spike Observed}}{\text{Concentration of Spike Added to Sample}} \times 100$$

Matrix Spikes

In addition, a matrix spike is analyzed with each set of samples. The material being extracted is spiked with a mixture of polyaromatic hydrocarbons appropriate for the fractions being analyzed. The recoveries of compounds in the spiking mix will provide information about the matrix effect of the sample c- the analytical methodology. Individual component recoveries of the matrix .e are calculated as follows:

$$\text{Percent Recovery} = \frac{SSR - SR}{SA} \times 100$$

Where: SSR = Spike sample results (µg/g)
SR = Sample results (µg/g)
SA = Spike added (µg/g) from spiking mix

Duplicate Samples

Duplicate analyses are performed every 20 samples or one for each project, whichever is more frequent.

$$\text{Percent Difference} = \frac{D_1 - D_2}{(D_1 + D_2)} \times 100$$

Where: D_1 = First sample value
D_2 = Second sample value (duplicate)

Detection Limits[1]

The method detection limit is defined as the minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from replicate analysis of a sample of a given matrix containing analyte[2].

$$MDL = t\ (N-1,\ 1-\alpha = .99) \times Sc$$

Where: $t\ (N-1,\ 1-\alpha = .99)$ is students t value for one-tailed test at the 99% confidence level with N-1 degree of freedom. Sc is the standard deviation of replicate analyses.

The method detection limit refers to samples processed through all steps comprising an established analytical procedure.

[1] Glaser, J.A., et al, "Trace Analyses for Wastewater," Environ. Sci. Tech., 15, 1426(1981).

[2] "Definition and Procedure for the Determination of the Method Detection Limit," Rev.1.12 45 EPA, Environmental Monitoring and Support Lab., Cincinnati, Jan. 1981.

The detection limit for each PNA is four parts-per-trillion in the well-water.

TABLE I

INSTRUMENT PARAMETERS

Polynuclear Aromatics Analysis

Gas Chromatograph

Hewlett Packard 5840 with HP7671A Autosampler
Column 30m x 0.24mm SE-54 Fused Silicon Capillary (J & W)
Column directly coupled to MS

Injection

Mode: Splitless
Sweep Initiation @ 0.5 minutes
Sweep Flow: 40ml/min. Helium
Carrier Flow: 1cm/sec. linear velocity

peratures

Injector: 275°
Temp. 1: 40°C for 3 minutes
Ramp: 10°C/minute
Temp. 2: 280°C for 20 minutes
Interface Temp: 275°C.
Injection Volume: 1 µl

Mass Spectrometer

Hewlett Packard 5985B GCMS
Electron Impact Mode: 70 eV
Delay: 10 minutes
SIM MODE
Dwell time: 100ms per ion
Multiplier Voltage: 2600V.
Source Temp. 225°C

Computer

Hewlett Packard 21MX-E
Disk Drives: HP7906 (20M byte) HP7920 (50M byte)
Tape Drive: Kennedy 9300 9-track dual density

TABLE II

Ion (abundances)

[illegible]pound	Primary	Confirming	R.T.
[illegible]hthalene	128 (100)	127 (13)	12.8
en[illegible] hylene	152 (100)	151 (21)	16.8
[illegible]naphthene	154 (100)	153 (120)	17.2
[illegible]orene	166 (100)	165 (94)	18.5
[illegible]nanthrene	178 (100)	176 (20)	20.9
[illegible]hracene	178 (100)	176 (21)	21.0
[illegible]oranthene	202 (100)	101 (11)	23.9
[illegible]ene	202 (100)	101 (14)	24.5
[illegible]zo (a) anthracene	228 (100)	*	27.5
[illegible]ysene	228 (100)	229 (19)	27.7
[illegible]zc[illegible]) fluoranthene	252 (100)	253 (23)	31.2
[illegible]zo (k) fluoranthene	252 (100)	253 (22)	31.2
[illegible]zo (a) pyrene	252 (100)	253 (24)	32.5
[illegible]eno (1,2,3-c,d) pyrene	276 (100)	*	38.9
[illegible]nzo (a,h) anthracene	278 (100)	*	39.0
[illegible]o (g,h,i) perylene	276 (100)	*	40.6

[illegible]o Secondary ion designated

TABLE III.

% RECOVERIES OF DEUTERATED SPIKES

Compound	Well #4A CAP #11646 Total ng Spiked	Total ng Recovered	% Recovery	Well #6 CAP #11458 Total ng Spiked	Total ng Recovered	% Recovery
D_8-Napthalene	1077	54	5.0	108	10	9.0
D_{10}-Phenathrene	1286	3600	280	129	180	140
D_{10}-Pyrene	1085	2170	200	109	229	210
D_{12}-Chrysene	1110	3100	280	111	144	130

Compound	Well #11 CAP #11459 Total ng Spiked	Total ng Recovered	% Recovery	Well #14A CAP #11462 Total ng Spiked	Total ng Recovered	% Recovery
D_8-Napthalene	269	43	16	1077	690	64
D_{10}-Phenanthrene	322	322	100	1286	2440	190
D_{10}-Pyrene	271	488	180	1085	2600	240
D_{12}-Chrysene	278	360	130	1110	2000	180

3/8/82
N.

WESTON
DESIGNERS CONSULTANTS

NORTHBROOK OFFICE COURT
SUITE 1502
666 WEST DUNDEE ROAD
NORTHBROOK, IL 60062
PHONE: 312-498-9090

8 March 1982

Mr. Paul Bitter, OSC
Superfund Sites Section
USEPA Region V
230 S Dearborn
Chicago, Illinois 60604

Re: Carbon Isotherm Data for
Selected PAH Compounds

Dear Paul:

Enclosed are the tables and the associated figure which summarize the analysis of the carbon isotherm data of Hickok and the USEPA. The data analyzed appeared in Table 6 of the E.A. Hickok and Assoc. Report "Drinking Water Treatment and Evaluation for St. Louis Park, MN. April 1981". This data was compared to USEPA carbon isotherm data for one PAH compound, Fluoranthene. The comparison was performed for this compound since a X/M relationship existed for all carbon dosages used by Hickok in their analysis.

I trust that this information will be of help to you. Should you have further questions, feel free to call me.

Very truly yours,

ROY F. WESTON, INC.

Robert J. Millman

Robert J. Millman, P.E.

RJM:cls

Enclosure

cc: R. Schoenberger
P. Lederman

FIGURE 1

EXAMPLE ADSORPTION OF PAH USING FLUORANTHENE CONTACTED WITH PAC

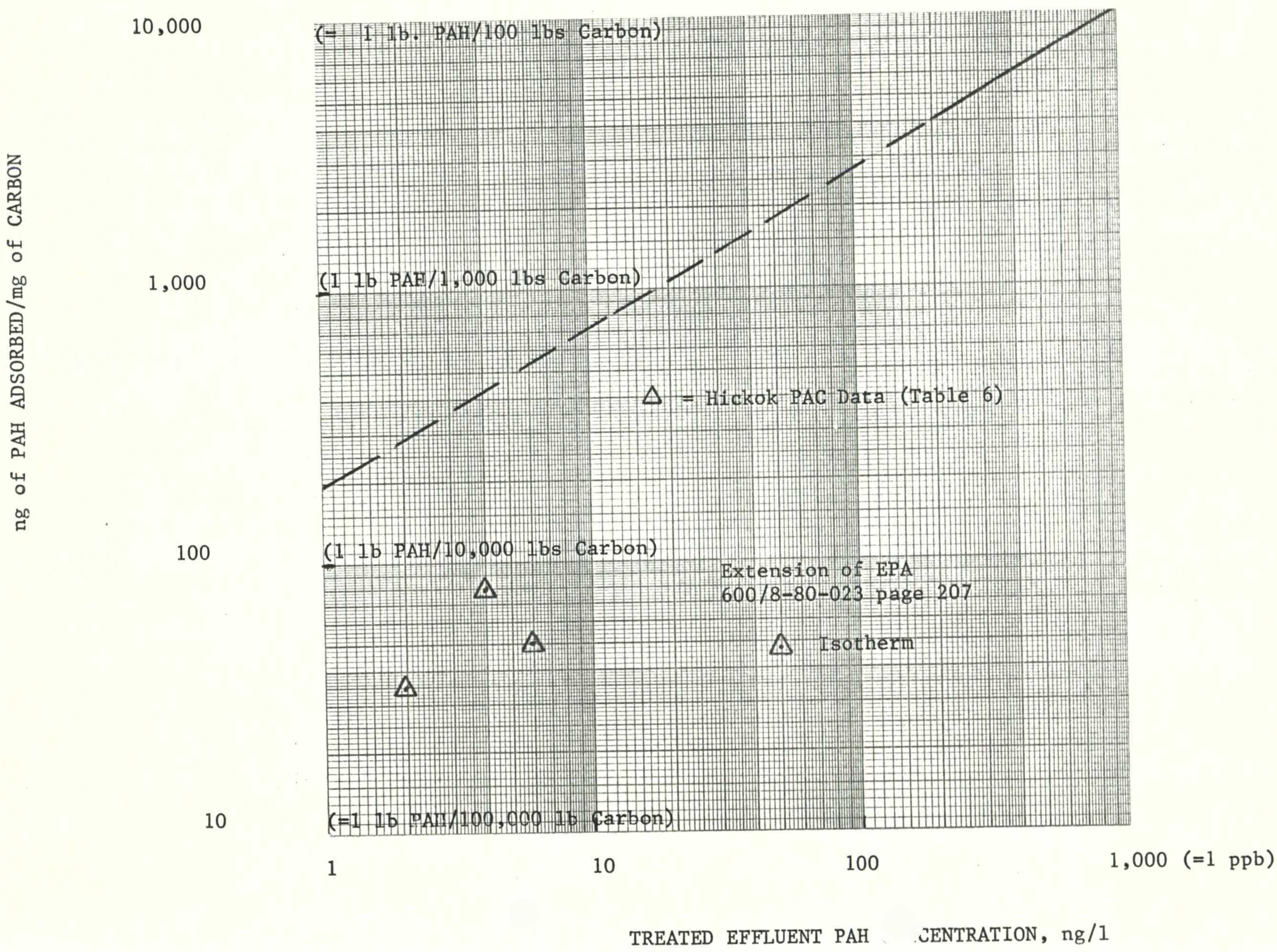


TABLE 1

CARBON ISOTHERM DATA FOR COMPOUNDS AS LISTED IN TABLE 6
HICKOK REPORT, APRIL 1981

PAC Dosage Applied	PAC 15 mg/l			PAC 11 mg/l		
Compound	Raw ng/l	Tr. ng/l	X/M ng/mg	Raw ng/l	Tr. ng/l	X/M ng/mg
Acenaphthene	1087	30	70.47	-	35	-
Acenaphtylene	250	11.5	15.90	4.3	4	0.03
Anthracene	613	4	40.60	492	4	44.36
Benzo(a) Anthracene	13	0.5	0.83	0.5	0.5	-
Benzo(a) Pyrene	0.5	0.5	-	0.5	0.5	-
Benzo(ghi) Perylene	2	2	-	2.5	2.5	-
Chrysene	6.5	6.5	-	3	3	-
Dibenzo(ah) Anthracene	0.5	0.2	0.02	1	1	-
Fluorene	121	1	8.00	217	4.5	19.32
Fluoranthene	1220	4	81.07	391	2	35.36
Napthalene	130	5.5	8.30	2	2	-
Phenanthrene	360	4.5	23.70	101	3	8.91
Pyrene	9	8	0.07	535	0.5	48.59
Benzo(k) Fluoranthene	0.15	0.15	-	0.5	0.5	-

NOTE: X/M - Unit of material adsorbed per unit of Carbon (ng/Mg)
Tr. - Treated water

TABLE 1(continued)

CARBON ISOTHERM DATA FOR COMPOUNDS AS LISTED IN TABLE 6
HICKOK REPORT, APRIL 1981

PAC Dosage Applied	PAC 8 mg/l			PAC 5.5 mg/l		
Compound	Raw ng/l	Tr. ng/l	X/M ng/mg	Raw ng/l	Tr. ng/l	X/M ng/mg
Acenaphthene	35	35	-	34	34	-
Acenaphtylene	4	4	-	95	95	-
Anthracene	4	4	-	23	23	-
Benzo(a) Anthracene	3.5	9.9	-	26	0.2	4.69
Benzo(a) Pyrene	2	0.5	0.19	32	1	5.64
Benzo(ghi) Perylene	0.5	0.5	-	25	0.8	4.40
Chrysene	9.2	2.1	0.89	2.2	2.2	-
Dibenzo(ah) Anthracene	1.5	1.4	0.01	6.6	1.5	0.93
Fluorene	4.5	4.5	-	0.65	0.65	-
Fluoranthene	403	6.3	49.59	270	14	46.55
Napthalene	2	2	-	38.5	38.5	-
Phenanthrene	3	3	-	7.5	7.5	-
Pyrene	22	2.5	2.44	2.5	2.5	-
Benzo(k) Fluoranthene	-	-	-	0.9	0.9	-

NOTE: X/M - Unit of material adsorbed per uint of Carbon (ng/Mg)
Tr. - Treated water

TABLE 2

CARBON ISOTHERM
COMPOUND: FLUORANTHANE

Carbon Dose mg/l	Treated mg/l	Removed mg/l	X/M mg/gm
0	0.0581	-	-
1.0	0.0140	0.0567	44.1
2.5	0.0014	0.0567	22.7
5	0.0008	0.0573	11.5
7.5	0.0012	0.0569	7.6
12.5	0.005	0.0576	4.6

Initial pH = 5.3

Source: EPA Publication 600/8-80-0203 pg. 207 "Carbon Adsorption Isotherms for Toxic Organics", April 1981

Preliminary report 3/2/82 N.

A Complete Concept in Consultation

CAPSULE LABORATORIES

A Division of Economics Laboratory, Inc
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Check numerics

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS IN MUNICIPAL WATER WELLS FOR THE CITY OF ST. LOUIS PARK

Prepared by:

CAPSULE LABORATORIES
605 West County Road E
Shoreview, Minnesota 55112

Date Submitted:

March 2, 1982

Analysis of Polynuclear aromatics*

Compound	Well #3 Capsule # 11645	Well #4A Capsule # 11646 (spiked)	Well #4B Capsule # 11647	Well #6 Capsule # 11458	Well #8 Capsule # 11648
Naphthalene	N.D. **	N.D.	5	N.D.	N.D.
Acenaphthylene	N.D.	N.D.	N.D.	N.D.	N.D.
Acenaphthene	N.D.	60	92	N.D.	N.D.
Fluorene	N.D.	26	46	N.D.	N.D.
Phenanthrene	N.D.	N.D.	N.D.	N.D.	N.D.
ıracene	N.D.	7	N.D.	N.D.	N.D.
Fluoranthene	N.D.	N.D.	6	N.D.	N.D.
yrene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (a) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
hrysene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (b) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (k) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (a) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
no (1,2,3-c,d) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
ibenzo (a,h) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
enzo (g,h,i) perylene	N.D.	N.D.	N.D.	N.D.	N.D.

Results expressed as parts-per-trillion (ng/l)

N.D. = Signal not observed or does not meet criteria for quantitation.

Analysis of Polynuclear aromatics*

Compound	Well #11 Capsule # 11459	Well #12 Capsule # 11460	Well #13 Capsule # 11461	Well #14A Capsule # 11462 (spiked)	Well #14B Capsule # 11463
:aphthalene	N.D. **	N.D.	N.D.	8	5
:cenaphthylene	N.D.	N.D.	N.D.	N.D.	N.D.
:cenaphthene	N.D.	N.D.	N.D.	N.D.	N.D.
:luorene	N.D.	N.D.	N.D.	43	6
:henanthrene	N.D.	N.D.	N.D.	N.D.	N.D.
ıracene	N.D.	N.D.	N.D.	28	N.D.
:luoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
:yrene	N.D.	N.D.	N.D.	N.D.	N.D.
:enzo (a) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
:hrysene	N.D.	N.D.	N.D.	N.D.	N.D.
:enzo (b) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
:enzo (k) fluoranthene	N.D.	N.D.	N.D.	N.D.	N.D.
:enzo (a) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
..deno (1,2,3-c,d) pyrene	N.D.	N.D.	N.D.	N.D.	N.D.
..benzo (a,h) anthracene	N.D.	N.D.	N.D.	N.D.	N.D.
:enzo (g,h,i) perylene	N.D.	N.D.	N.D.	N.D.	N.D.

Results expressed as parts-per-trillion (ng/l)

N.D. = Signal not observed or does not meet criteria for quantitation.

Analysis of Polynuclear aromatics*

Compound	Well #15A Capsule # 11464 (Spiked)	Well #15B Capsule # 11465	Well #16 Capsule # 11649		
Naphthalene	4	N.D.**	N.D.		
Acenaphthylene	70	N.D.	N.D.		
Acenaphthene	41	N.D.	N.D.		
Fluorene	700	430	N.D.		
Phenanthrene	83	N.D.	N.D.		
hracene	160	N.D.	N.D.		
Fluoranthene	380	360	N.D.		
Pyrene	260	N.D.	N.D.		
Benzo (a) anthracene	14	N.D.	N.D.		
Chrysene	14	N.D.	N.D.		
Benzo (b) fluoranthene	N.D.	N.D.	N.D.		
Benzo (k) fluoranthene	N.D.	N.D.	N.D.		
Benzo (a) pyrene	N.D.	N.D.	N.D.		
Indeno (1,2,3-c,d) pyrene	N.D.	N.D.	N.D.		
enzo (a,h) anthracene	N.D.	N.D.	N.D.		
Benzo (g,h,i) perylene	N.D.	N.D.	N.D.		

*Results expressed as parts-per-trillion (ng/l)

** N.D. = Signal not observed or does not meet criteria for quantitation.

GC/MS ANALYSIS OF POLYNUCLEAR AROMATIC HYDROCARBONS

Sampling Equipment

Sampling resin beds used for organic enrichment are connected to a water source by an all-teflon manifold. The teflon manifold is designed to collect samples in duplicate by splitting sample flow with a tee to two resin beds. The inlet of the manifold is compatible with a 1/8" NPT female fitting on the water source. Two teflon needle valves (one on each side of the tee) are used to control water flow through the resin beds. A differential pressure of at least 20 psig is necessary for adequate flow control. When particulate levels are high, a teflon prefilter is placed upstream of the resin beds to remove particulates.

Sampling Procedure

Before sampling, all manifold parts are cleaned with HPLC-grade acetone and hexane. Preparation of the resin beds consists of flushing each with 4.0 ml HPLC-grade methanol, then 10.0 ml HPLC-grade water. One of the beds is spiked with isotope compounds in the laboratory. The spike level should be similar in concentration to the non-isotopic compounds being analyzed.

At the sampling site, the assembled teflon manifold and resin bed connections are leak-tested. The flow rate through each resin bed is adjusted using the flow valve and the sample flow volume maintained throughout sampling by periodic checks. The water after passing through each resin bed is collected in tared carboys. At the end of the sampling period, the water volume sampled is determined by weighing the carboy and water. At the completion of the sampling, the resin beds are wrapped in foil and kept refrigerated until analysis

Resin Bed Elution

Each resin bed used to collect and concentrate polynuclear aromatic compounds is eluted using acidified tetrahydrofuran (THF). The acidified THF is then passes through a micro-drying column to remove water. The dryed THF extract is collected in a 0.1 ml graduated vial. The micro-drying column is rinsed several times with acidified THF. The volume of acidified THF is reduced under a gentle stream of nitrogen at room temperature. Finally, the concentrated extract is spiked with an isotope internal standard (D_{10} anthracene).

GC/MS Analysis

The extracts are stored in suitable vials until ready for analysis. A 1 µl aliquot is injected on the column in a splitless injection mode. Single ion monitoring data is continuously acquired and the data stored for later workup. Instrumental parameters are described in Table I.

Data Reduction - Quantitation

The single ion chromatograms are plotted for the characteristic ion of each polynuclear aromatic being analyzed. Areas are then obtained for any peak with a retention time falling within a one minute window relative to the

standard run. Confirmation of identity is based on presence of the EPA selected ions (see Table II) for the individual compound, and all ions must maximize within one scan of each other. Futhermore, the ions must meet spectral integrity criteria for relative ratios (±20%). The areas under each characteristic ion are used to determine the extract concentration. The areas are compared to the internal standard intensity based on the following formula.

$$\text{Concentration}_{unk} = \frac{(\text{Area}_{unk})\quad(\text{Conc}_{IS})}{(\text{Area}_{IS})\ (\text{R.F.}_{unk})\ (\text{Dilution})}$$

where: unk = priority pollutant being quantitated
IS = internal standard D_{10} anthracene
R.F.= response factor for the particular compound

Recovery Determinations

Each sample to be extracted is spiked with a surrogate standard (a deuterated analog). These materials are carried through the work-up procedure and quantitated along with the normal pollutants. The intensity of these spikes when compared to the area for D_{10} anthracene added to the final extract allows a percent recovery to be determined for each extraction.

$$\text{Percent Recovery} = \frac{\text{Concentration of Spike Observed}}{\text{Concentration of Spike Added to Sample}} \times 100$$

Matrix Spikes

In addition, a matrix spike is analyzed with each set of samples. The material being extracted is spiked with a mixture of polyaromatic hydrocarbons appropriate for the fractions being analyzed. The recoveries of compounds in the spiking mix will provide information about the matrix effect of the sample on the analytical methodology. Individual component recoveries of the matrix spike are calculated as follows:

$$\text{Percent Recovery} = \frac{\text{SSR} - \text{SR}}{\text{SA}} \times 100$$

Where: SSR = Spike sample results (µg/g)
SR = Sample results (µg/g)
SA = Spike added (µg/g) from spiking mix

Duplicate Samples

Duplicate analyses are performed every 20 samples or one for each project, whichever is more frequent.

$$\text{Percent Difference} = \frac{D_1 - D_2}{(D_1 + D_2)} \times 100$$

Where: D_1 = First sample value
D_2 = Second sample value (duplicate)

Detection Limits[1]

The method detection limit is defined as the minimum concentration of a substance that can be identified, measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from replicate analysis of a sample of a given matrix containing analyte[2].

$$MDL = t\ (N-1,\ 1-\alpha = .99) \times Sc$$

Where: $t\ (N-1,\ 1-\alpha = .99)$ is students t value for one-tailed test at the 99% confidence level with N-1 degree of freedom.
Sc is the standard deviation of replicate analyses.

The method detection limit refers to samples processed through all steps comprising an established analytical procedure.

[1] Glaser, J.A., et al, "Trace Analyses for Wastewater," Environ. Sci. Tech., 15, 1426(1981).

[2] "Definition and Procedure for the Determination of the Method Detection Limit," Rev.1.12 45 EPA, Environmental Monitoring and Support Lab., Cincinnati, Jan. 1981.

TABLE I

INSTRUMENT PARAMETERS

Polynuclear Aromatics Analysis

Gas Chromatograph

Hewlett Packard 5840 with HP7671A Autosampler
Column 30m x 0.24mm SE-54 Fused Silicon Capillary (J & W)
Column directly coupled to MS

Injection

Mode: Splitless
Sweep Initiation @ 0.5 minutes
Sweep Flow: 40ml/min. Helium
Carrier Flow: 1cm/sec. linear velocity

Temperatures

Injector: 275°
Temp. 1: 40°C for 3 minutes
Ramp: 10°C/minute
Temp. 2: 280°C for 20 minutes
Interface Temp: 275°C.
Injection Volume: 1 µl

Mass Spectrometer

Hewlett Packard 5985B GCMS
Electron Impact Mode: 70 eV
Delay: 10 minutes
SIM MODE
Dwell time: 100ms per ion
Multiplier Voltage: 2600V.
Source Temp. 225°C

Computer

Hewlett Packard 21MX-E
Disk Drives: HP7906 (20M byte) HP7920 (50M byte)
Tape Drive: Kennedy 9300 9-track dual density

TABLE II

Ion (abundances)

Compound	Primary	Confirming	R.T.
Naphthalene	128 (100)	127 (13)	12.8
Acenaphthylene	152 (100)	151 (21)	16.8
Acenaphthene	154 (100)	153 (120)	17.2
Fluorene	166 (100)	165 (94)	18.5
Phenanthrene	178 (100)	176 (20)	20.9
Anthracene	178 (100)	176 (21)	21.0
uoranthene	202 (100)	101 (11)	23.9
Pyrene	202 (100)	101 (14)	24.5
Benzo (a) anthracene	228 (100)	*	27.5
Chrysene	228 (100)	229 (19)	27.7
Benzo (b) fluoranthene	252 (100)	253 (23)	31.2
Benzo (k) fluoranthene	252 (100)	253 (22)	31.2
Benzo (a) pyrene	252 (100)	253 (24)	32.5
Indeno (1,2,3-c,d) pyrene	276 (100)	*	38.9
enzo (a,h) anthracene	278 (100)	*	39.0
Benzo (g,h,i) perylene	276 (100)	*	40.6

* No Secondary ion designated

12/9/81
N.

PAH Samples
St. Louis Park, Minnesota
Municipal Raw Water Samples

Date Collected: December 9, 1981

Field #	Municipal Well #	
1	15	(Code as #17)
2	15	
3	14	
4	14	
5	14	
6	14	
7	14	
8	16	

SLP 15 = Municipal Well #

1 = Field #

PAH Samples
St. Louis Park, Minnesota
Municipal Raw Water Samples

Date Collected December 9, 1981

Field number	Municipal Well number
1	17
2	15
3.	14
4	14
5	14
6	14
7	14
8	16

recorded on. both follows:
$\boxed{SLP\ 15}$ = municip. well no.
$\boxed{2}$ = field no.

Eight municipal raw water samples were collected on December 9, 1981 from the St Louis Park, Mn. municipal water system. The samples were collected between 1 p.m. and 3 p.m. according to standard Health Department [illegible]. The samples were placed in [illegible] ice chests and packed with ice. The samples were turned over to Rick [illegible] at 4:30 p.m. December 9 1981 [illegible]

Richard K Ferguson - took possession at 4^30 pm on December 9, 1981.

Samples were left with [illegible] at 5^00 pm for pick up at 5^15 by Federal Express.

RECEIVED

JUL 01 1982

GCA

CROSS REFERENCE LIST OF WATER SAMPLES RECEIVED FOR PAH ANALYSIS

(EPA Contract No. 68-01-6316)
(GCA 1-452-124)

Sampling date	Sample code	GCA Control No.
1/13/82	UM-827	18825
	UM-840	18826
	UM-847	18827
	UM-859	18828
	Ford Dam	18829
1/19/82	Field Blank (1/19/82)	18931
	EFF E	18932
	EFF W	18933
	Ford Dam	18934
	Gray Cloud	18935
	INF	18936
	UM-827	18937
	UM-840	18938
	UM-847	18939
	UM-859	18940
1/21/82	Field Blank (1/21/82)	18977
	EFF E	18978
	EFF W	18979
	INF E	18980
	INF ISCO	18981
1/26/82	Field Blank (1/26/82)	19099
	INF E	19100
	INF E ISCO	19101
	EFF E	19102
	EFF W	19103
1/28/82	Field Blank (1/28/82)	19157
	EFF E II°	19158
	EFF W II°	19159
	INF E I°	19160
	INF I° E ISCO	19161